

HAC TEST REPORT

Report No.: SET2014-00659
Product: Toughshield
Model No.: R750
Brand Name: Toughshield
Applicant: Toughshield devices ltd
Address: 2nd Floor, Belgravia House, 34-44 Circular Road,
Douglas, Isle of Man. IM1 1AE
Issued by: CCIC-SET
Lab Location: Electronic Testing Building, Shahe Road, Xili, Nanshan
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Test Report

Product.....: Toughshield
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Brand Name.....: Toughshield
Applicant.....: Toughshield devices ltd
Applicant Address.....: 2nd Floor, Belgravia House, 34-44 Circular Road,
 Douglas, Isle of Man. IM1 1AE
Manufacturer.....: Toughshield devices ltd
Manufacturer Address.....: 2nd Floor, Belgravia House, 34-44 Circular Road,
 Douglas, Isle of Man. IM1 1AE

Test Standards.....:

ANSI C63.19-2007 American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids

FCC 47CFR § 20.19 American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids

KDB 285076 D01HAC Guidance v04 Provides equipment authorization guidance for mobile handsets subject to the requirements of Section 20.19 for hearing aid compatibility.

Rating.....: HAC : M4
 T-Coil : T3

Test Result.....: Pass

Tested by Mei Chun 2014-01-24
 Mei chun , Test EGINEER

Reviewed by.....: Shuangwen Zhang 2014-01-24
 Shuangwen Zhang, Senior EGINEER

Approved by.....: Wu Li'an 2014-01-24
 Wu Li'an , Manager

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This Test Report consists of the following Annexes:

Annex A: Test Layout

Annex B: Sample Photographs

Annex C: System Performance Check Data

Annex D: Calibration Certificate of Probe and Dipoles

1. GENERAL CONDITIONS

1.1 This report only refers to the item that has undergone the test.

1.2 This report standalone dose not constitute or imply by its own an approval of the product by the certification Bodies or competent Authorities.

1.3 This document is only valid if complete; no partial reproduction can be made without written approval of CCIC-SET

1.4 This report cannot be used partially or in full for publicity and/or promotional purposes without previous written approval of CCIC-SET and the Accreditation Bodies, if it applies.

2. Administrative Date

2.1. Identification of the Responsible Testing Laboratory

Company Name: CCIC-SET

Department: EMC & RF Department

Address: Electronic Testing Building, Shahe Road, Nanshan District,
ShenZhen, P. R. China

Telephone: +86-755-26629676

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Responsible Test Lab Managers: Mr. Wu Li'an

2.2. Identification of the Responsible Testing Location(s)

Company Name: CCIC-SET

Address: Electronic Testing Building, Shahe Road, Nanshan District,
Shenzhen, P. R. China

2.3. Organization Item

CCIC-SET Report No.: SET2014-00659

CCIC-SET Project Leader: Mr. Li Sixiong

CCIC-SET Responsible for accreditation scope: Mr. Wu Li'an

Start of Testing: 2014-01-22

End of Testing: 2014-01-22

2.4. Identification of Applicant

Company Name: Toughshield devices ltd

Address: 2nd Floor, Belgravia House, 34-44 Circular Road, Douglas,
Isle of Man. IM1 1AE

2.5. Identification of Manufacture

Company Name: Toughshield devices ltd

Address: 2nd Floor, Belgravia House, 34-44 Circular Road, Douglas,
Isle of Man. IM1 1AE

Notes: This data is based on the information by the applicant.

3. Equipment Under Test (EUT)

3.1. Identification of the Equipment under Test

Sample Name: Toughshield

Type Name: R750

Brand Name: Toughshield

General description:	Support Band	GSM850MHz/1900MHz/900MHz/1800MHz WCDMA 850MHz/ 1900MHz/ 2100MHz Wi-Fi 2.4GHz/ Bluetooth 2.4GHz/NFC
	Test Band	GSM 850MHz/ GSM 1900MHz WCDMA 850MHz/ WCDMA 1900MHz
	Development Stage	Identical Prototype
	Accessories	Power Supply
	Antenna type	PIFA Antenna
	Operation mode	GSM GPRS /EGPRS: Multislot Class12,Class B WCDMA/HSDPA/HSUPA/HSPA+
	Modulation mode	GMSK, 8PSK, QPSK, 16QAM, DSSS, OFDM, GFSK/ π /4-DQPSK/8-DPSK

NOTE:

- The EUT is a model of Toughshield operating in GSM850/1900/900/1800, WCDMA850/WCDMA1900/WCDMA2100 band, Bluetooth 2.4GHz, Wi-Fi in 2.4GHz and NFC.
- Please refer to Appendix C for the photographs of the EUT. For a more detailed features description about the EUT, please refer to User's Manual.

3.2 Summary of test results

3.2.1 Test Standards

No.	Identity	Document Title
1	FCC 47 CFR Part 20.19	Hearing aid-compatible mobile handsets.
2	ANSI C63.19:2007	American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids
3	KDB 285076 D01 HAC Guidance v04	Provides equipment authorization guidance for mobile handsets subject to the requirements of Section 20.19 for hearing aid compatibility

3.2.2 Summary Of HAC Rating

Summary of M-Rating

Band	M-Rating	Frequency response
GSM850	M4	PASS
GSM1900	M4	PASS
WCDMA850	M4	PASS
WCDMA1900	M4	PASS

Summary of T-Rating

Band	T-Rating	Frequency response
GSM850	T3	PASS
GSM1900	T3	PASS
WCDMA850	T4	PASS
WCDMA1900	T4	PASS

4 Hearing Aid Compatibility (HAC)

4.1 Introduction

The purpose of the Hearing Aid Compatibility extension is to enable measurements of the near electric and magnetic fields generated by wireless communication devices in the region controlled for use by a hearing aid in accordance with ANSI-C63.19-2011 FCC has granted a request for waiver of the HAC rules in section 20.19 for dual band GSM handsets. The waiver

has specific conditions, as stated in the order (FCC 05-166) and expires 1 August 2007.

The purpose of this standard is to establish categories for hearing aids and for WD (wireless communications devices) that can indicate to health care practitioners and hearing aid users which hearing aids are compatible with which WD, and to provide tests that can be used to assess the electromagnetic characteristics of hearing aids and WD and assign them to these categories. The various parameters required, in order to demonstrate compatibility and accessibility are measured. The design of the standard is such that when a hearing aid and WD achieve one of the categories specified, as measured by the methodology of this standard, the indicated performance is realized.

In order to provide for the usability of a hearing aid with a WD, several factors must be coordinated:

- a) Radio frequency (RF) measurements of the near-field electric and magnetic fields emitted by a WD to categorize these emissions for correlation with the RF immunity of a hearing aid.
- b) Magnetic field measurements of a WD emitted via the audio transducer associated with the T-coil mode of the hearing aid, for assessment of hearing aid performance.
- c) Measurements with the hearing aid and a simulation of the categorized WD T-coil emissions to assess the hearing aid RF immunity in the T-coil mode.

The WD radio frequency (RF) and audio band emissions are measured.

Hence, the following are measurements made for the WD:

- a) RF E-Field emissions
- b) RF H-Field emissions
- c) T-coil mode, magnetic signal strength in the audio band
- d) T-coil mode, magnetic signal and noise articulation index
- e) T-coil mode, magnetic signal frequency response through the audio band

Corresponding to the WD measurements, the hearing aid is measured for:

- a) RF immunity in microphone mode
- b) RF immunity in T-coil mode

4.2 Description of Test System

4.2.1 COMOHAC E-FIELD PROBE



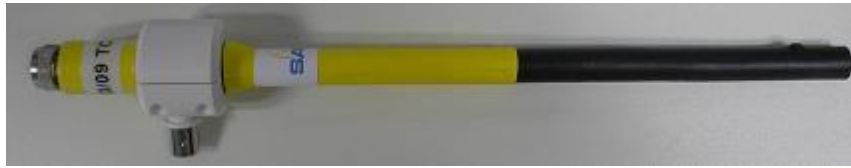
Serial Number:	SN 02/12 EPH34
Frequency:	0.7GHz – 2.5GHz
Probe length:	330mm
Length of one dipole:	3.3mm
Maximum external diameter:	8mm
Probe extremity diameter:	5mm
Distance between dipoles/probe extremity:	3mm
Resistance of the three dipole (at the connector):	Dipole 1:R1=1.201 MΩ Dipole 2:R1=1.193 MΩ Dipole 3:R3=0.994 MΩ □

4.2.2 COMOHAC H-FIELD PROBE



Serial Number:	SN 02/12 HPH45
Frequency:	0.7GHz – 2.5GHz
Probe length:	330mm
Length of one dipole:	3.3mm
Maximum external diameter:	8mm
Probe extremity diameter:	5mm
Distance between dipoles/probe extremity:	3mm
Resistance of the three dipole (at the connector):	Dipole 1:R1=0.296 MΩ Dipole 2:R1=0.459 MΩ Dipole 3:R3=0.271 MΩ □

4.2.3 COMO HAC T-COIL PROBE



Serial Number:	SN 24/11 TCP23
Frequency range:	200 Hz -5000 Hz
Dimensions:	6.55mm length*2.29mm diameter
DC resistance:	860.6Ω
Wire size:	51 AWG
Inductance:	132.1 mH at 1kHz
Sensitivity:	-60.20 dB (V/A/m) at 1kHz

4.2.4 System Hardware

The HAC positioning ruler is used to position the phone properly with the regard to the position of the probe during a measurement. The positioning system is made of a dedicated frame that can be fixed on the table. The tip of the probe is positioned on a reference point located on the top of the positioning ruler. The distance between this reference point and the cross located on the ruler being known, the speaker of the phone is positioned on this cross in order to make sure both probe and phone are positioned properly.

During the measurement, the HAC ruler has to be removed so that it does not interfere with the measurement.



Position device

5 OPERATIONAL CONDITIONS DURING TEST

5.1 Schematic Test Configuration

During SAR test, EUT was operating in Traffic Mode (Channel Allocated) at Normal Voltage Condition. A communication link is set up with a System Simulator (SS) by air link, and a call is established.

The Absolute Radio Frequency Channel Number (ARFCN) was allocated to 128, 190 and 251 respectively in the case of GSM 850MHz, or to 512, 661 and 810 respectively in the case of PCS 1900MHz, or to 4132, 4183 and 4233 respectively in the case of WCDMA 850MHz, or to 9262, 9400 and 9538 respectively in the case of WCDMA 1900MHz. The EUT was commanded to operate at maximum transmitting power.

The EUT should use its internal transmitter. The antenna(s), battery and accessories shall be those specified by the manufacturer. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output. If a wireless link was used, the antenna connected to the output of the base station simulator shall be placed at least 50 cm away from the handset.

The signal transmitted by the simulator to the antenna feeding point should be lower than the output power level of the handset by at least 35 dB

Air-interface	Band (MHz)	Type	C63.19-2007 Tested	Simultaneous Transmissions Scenarios invoice (Not to be tested)	Reduced power	VOIP
GSM	850	Voice	Yes	Yes: WIFI or BT	N/A	N/A
	1900	Voice	Yes	Yes: WIFI or BT	N/A	N/A
	GPRS	Data	N/A	N/A	N/A	N/A
WCDMA	850	Voice	Yes	Yes: WIFI or BT	N/A	N/A
	1900	Voice	Yes	Yes: WIFI or BT	N/A	N/A
	HSDPA	Data	N/A	N/A	N/A	N/A
	HSUPA	Data	N/A	N/A	N/A	N/A
WIFI	2450	Data	N/A	Yes GSM or WCDMA	N/A	N/A
BT	2450	Data	N/A	Yes GSM or WCDMA	N/A	N/A
NFC	13.56	Data	N/A	Yes GSM or WCDMA	N/A	N/A

The volume is at the maximum value, and the backlight of the phone is turned off. The Manufacturer doesn't design HAC mode software on the EUT

5.2 HAC Measurement System

The HAC measurement system being used is the COMO HAC system, the system is controlled remotely from a PC, which contains the software to control the robot and data acquisition equipment. The software also displays the data obtained from test scans.

In operation, the system first does a 2D scan at a fixed depth within a 50mm*50mm area. When the maximum HAC point has been found, the system will then carry out a 3D scan centred at that point to determine volume averaged HAC level.



WD reference and plane for RF emission measurements

5.3 Magnetic measurement locations for the WD

T-Coil measurement points and reference plane The following figure illustrates the three standard probe orientations. Position 1 is the axial orientation of the probe coil; orientation 2 and orientation 3 are radial orientations. The space between the measurement positions is not fixed. It is recommended that a scan of the EUT be done for each probe coil orientation and that the maximum level recorded be used as the reading for that orientation of the probe coil.

1) The reference plane is the planar area that contains the highest point in the area of the phone that normally rests against the user's ear. It is parallel to the centerline of the receiver.

ver area of the phone and is defined by the points of the receiver-end of the EUT handset, which, in normal handset use, rest against the ear.

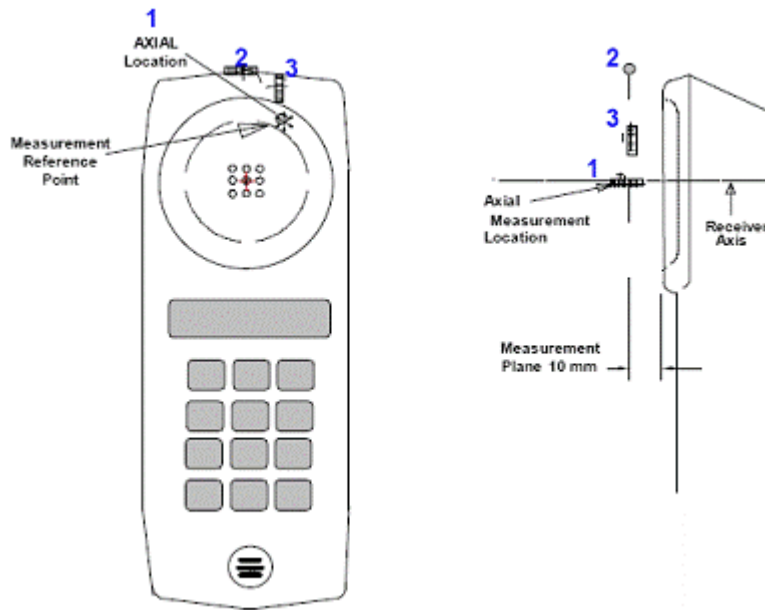
2) The measurement plane is parallel to, and 10 mm in front of, the reference plane.

3) The reference axis is normal to the reference plane and passes through the center of the receiver speaker section (or the center of the hole array); or may be centered on a secondary inductive source. The actual location of the measurement point shall be noted in the test report as the measurement reference point.

4) The measurement points may be located where the axial and radial field intensity measurements are optimum with regard to the requirements. However, the measurement points should be near the acoustic output of the EUT and shall be located in the same half of the phone as the EUT receiver. In a EUT handset with a centered receiver and a circularly symmetrical magnetic field, the measurement axis and the reference axis would coincide.

5) The relative spacing of each measurement orientation is not fixed. The axial and two radial orientations should be chosen to select the optimal position.

6) The measurement point for the axial position is located 10 mm from the reference plane on the measurement axis. The actual location of the measurement point shall be noted in test reports and designated as the measurement reference point.



Axis and planes for EUT audio frequency magnetic field measurements

5.4 Equipments and results of validation testing

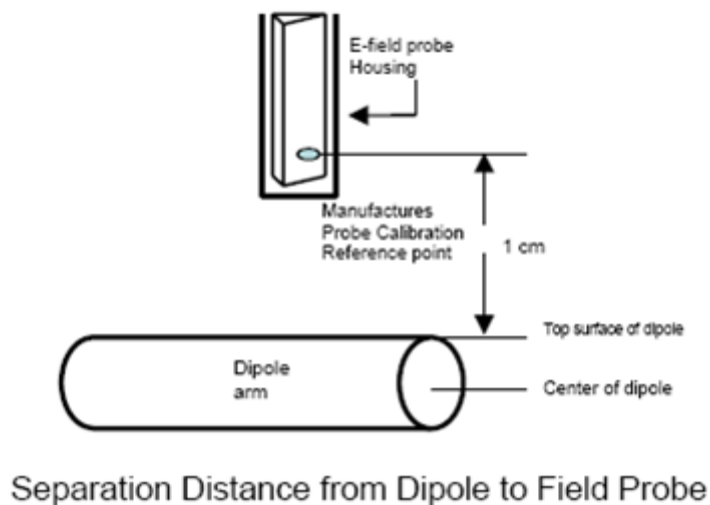
Important equipments :

Equipment description	Manufacturer/Model	Identification No.
E-Field Probe	SATIMO/SCE	SN 02/12 EPH34
H-Field Probe	SATIMO/SCH	SN 02/12 HPH45
T-Coil Probe	SATIMO/STCOIL	SN 24/11 TCP23
Dipole	SATIMO/SIDB835	SN 18/12 DHA37
Dipole	SATIMO/SIDB1900	SN 18/12 DHB42
TMFS	SATIMO/STMFS	SN 22/12 TMFS15
Vector Network Analyzer	ZVB8	1145.1010.08
Amplifier	Nucletudes	143060
Power Meter	NRVS	1020.1809.02
Multimeter	Keithley - 2000	4014020

5.4.1 System Check Parameters

The input signal was an unmodulated continuous wave. The following points were taken into consideration in performing this check:

- Average Input Power $P = 100\text{mW RMS}$ (20dBm RMS) after adjustment for return loss
- The test fixture must meet the 2 wavelength separation criterion
- The proper measurement of the 1 cm probe to dipole separation, which is measured from top surface of the dipole to the calibration reference point of the sensor, defined by the probe manufacturer is shown in the following diagram:



RF power was recorded using both an average reading meter and a peak reading meter. Readings of the probe are provided by the measurement system.

To assure proper operation of the near-field measurement probe the input power to the dipole shall be commensurate with the full rated output power of the wireless device (e.g. - for a cellular phone wireless device the average peak antenna input power will be on the order of 100mW (i.e. - 20dBm) RMS after adjustment for any mismatch.

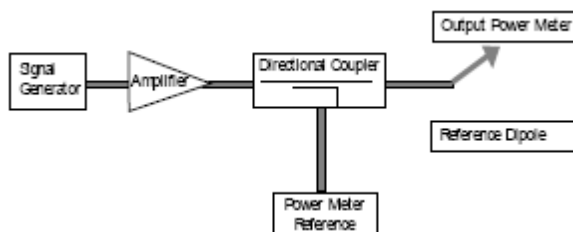
5.4.2 Validation Procedure

A dipole antenna meeting the requirements given in PC63.19 was placed in the position normally occupied by the WD.

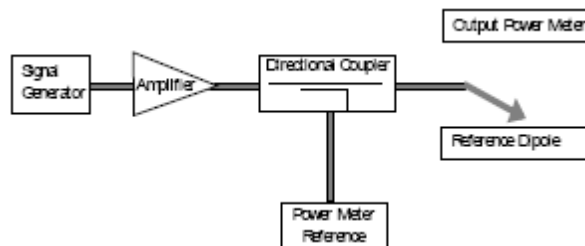
The length of the dipole was scanned with both E-field and H-field probes and the maximum values for each were recorded.

Using the near-field measurement system, scan the antenna over the radiating dipole and record the greatest field reading observed. Due to the nature of E-fields about free-space dipoles, the two E-field peaks measured over the dipole are averaged to compensate for non-parallelity of the setup see manufacturer method on dipole calibration certificates, field strength measurements shall be made only when the probe is stationary.

RF power was recorded using both an average and a peak power reading meter.



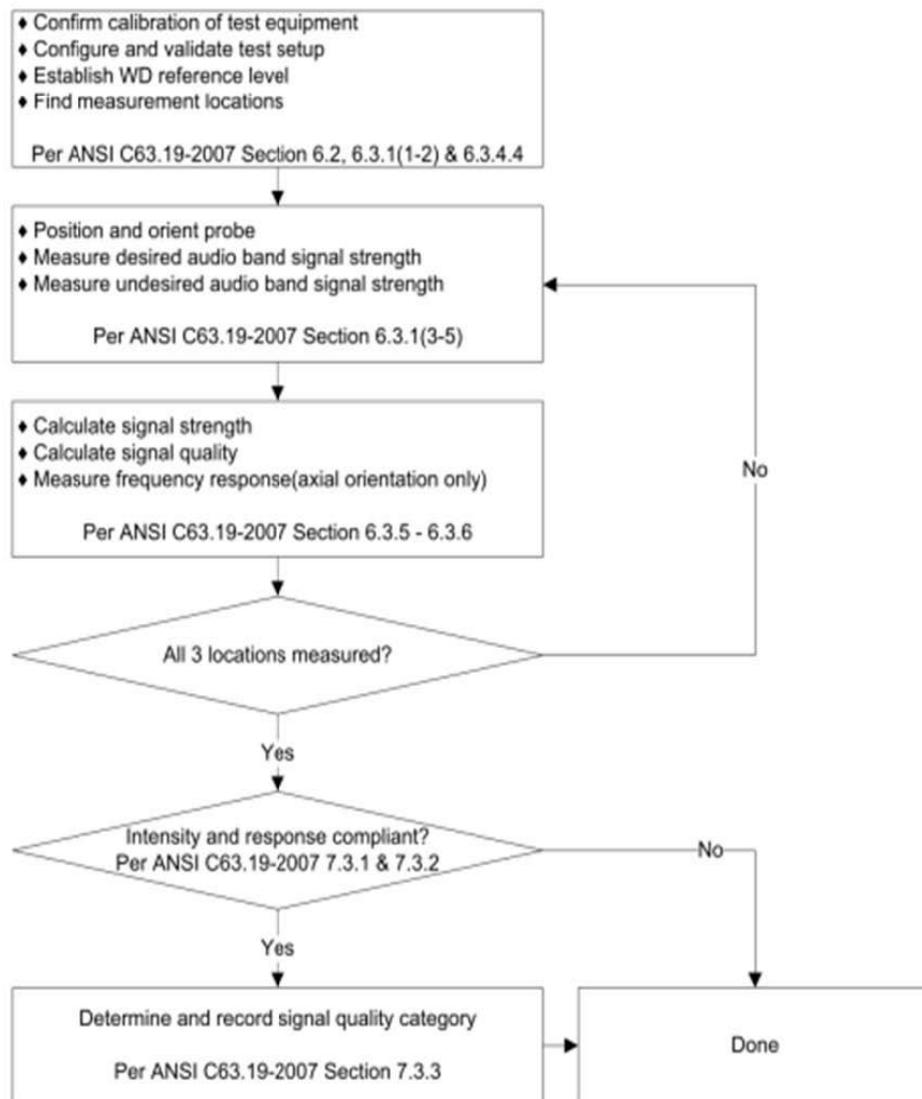
Setup for Desired Output Power to Dipole



Setup to Dipole

Using this setup configuration, the signal generator was adjusted for the desired output power (100mW) at a specified frequency. The reference power from the coupled port of the directional coupler is recorded. Next, the output cable is connected to the reference dipole.

HAC Measurement Process Diagram



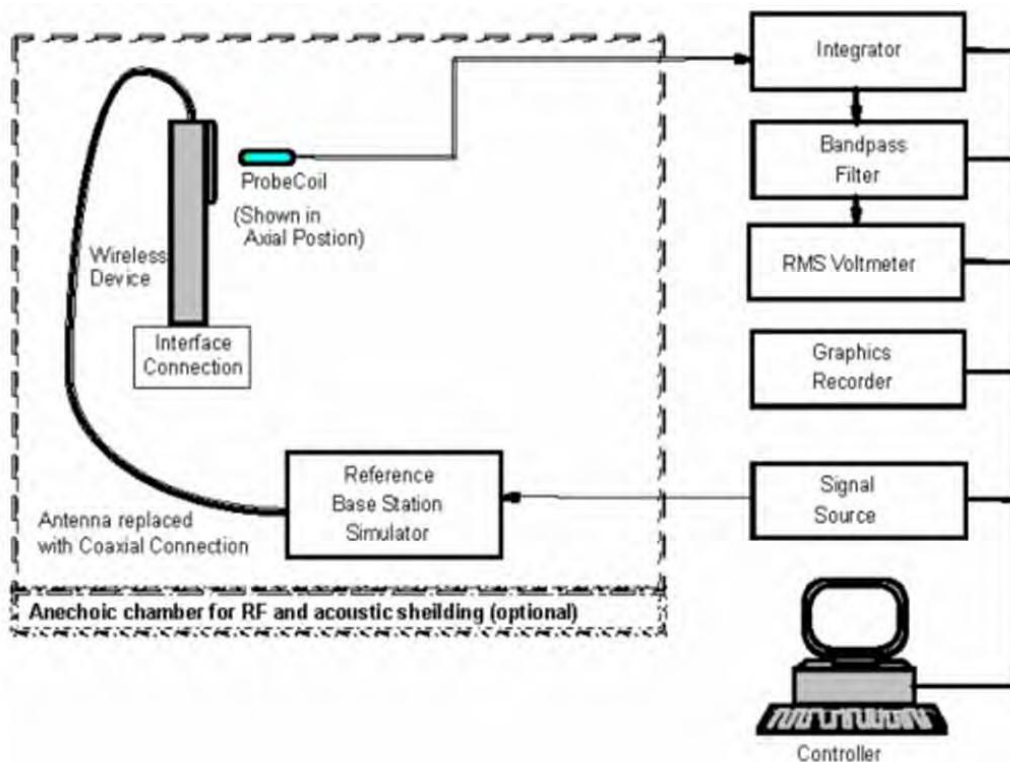
System Audio Validation

Put the phone on call and select the CMU decoder cal. When the decoder cal is selected, a full scale(3.14 dBm) signal is provided to the speech port. Measure the voltage from the speech connector using the provided CMU speech cable. For this connect the GSM/WCDMA out connector (or CDMA2K OUT connector) to the front panel of the Keithley and read the AC voltage. With the speech cable provided by Satiom, the GSM/WCDMA OUT connector 2 and the CDMA2K OUT connector is the connector 4.

Put the phone on call and select the CMU encoder cal. And send a signal to the CMU and check to avoid influencing the calibration. An RMS voltmeter would indicate 100 mV RMS during the first phase and 10 mV RMS during the second phase. After the first two phases, the two input channels are both calibrated for absolute measurements of voltages. The resulting factors are displayed above the multi-meter window.

After phases 1 and 2, the input channels are calibrated to measure exact voltages. This is required to use the inputs for measuring voltages with their peak and RMS value.

In phase 3, a multi-sine signal covering each third-octave band from 50 Hz to 10 kHz is generated and applied to both audio outputs. The probe should be positioned in the center of the AMCC and aligned in the z-direction, the field orientation of the AMCC. The “Coil In” channel is measuring the voltage over the AMCC internal shunt, which is proportional to the magnetic field in the AMCC. At the same time, the “Probe In” channel samples the amplified signal picked up by the probe coil and provides it to a numerical integrator. The ratio of the two voltages in each third-octave filter leads to the spectral representation over the frequency band of interest. The Coil signal is scaled in dBV, and the Probe signal is first integrated and normalized to show dB A/m. The ratio probe-to-coil at the frequency of 1 kHz is the sensitivity which will be used in the consecutive T-Coil jobs..



T-Coil measurement test setup

T-Coil Measurement Procedure

The following illustrate a typical T-Coil signal test scan over a wireless communications device:

- a. Position the EUT in the test setup and connect the EUT RF connector to a base station simulator.
- b. The drive level to the EUT is set such that the reference input level defined in 6.3.2.1, Table 6.1 is input to the base station simulator in the 1 kHz, 1/3 octave band. This drive level shall be used for the T-Coil signal test (ABM1) at $f = 1$ kHz. Either a sine wave at 1025 Hz or a voice-like signal, band-limited to the 1 kHz 1/3 octave, as defined in 6.3.2, shall be used for the reference audio signal. If interference is found at 1025 Hz an alternate nearby reference audio signal frequency may be used. The same drive level will be used for the

ABM1 frequency response measurements at each 1/3 octave band center frequency. The EUT volume control may be set at any level up to maximum, provided that a signal at any frequency at maximum modulation would not result in clipping or signal overload.

c. Determine the magnetic measurement locations for the EUT, if not already specified by the manufacturer, as described in 6.3.4.1.1 and 6.3.4.4.

d. At each measurement location, measure and record the desired T-Coil magnetic signals (ABM1 at f_i) as described in 6.3.4.2 in each individual ISO 266-1975 R10 standard 1/3 octave band. The desired audio band input frequency (f_i) shall be centered in each 1/3 octave band maintaining the same drive level as determined in Step 2) and the reading taken for that band. Equivalent methods of determining the frequency response may also be employed, such as fast Fourier transform (FFT) analysis using noise excitation or input–output comparison using simulated speech. The full-band integrated or half-band integrated probe output, as described in D.18, may be used, as long as the appropriate calibration curve is applied to the measured result, so as to yield an accurate measurement of the field magnitude. (The resulting measurement shall be an accurate measurement in dB A/m.) All measurements of the desired signal shall be shown to be of the desired signal and not of an undesired signal. This may be shown by turning the desired signal on and off with the probe measuring the same location. If the scanning method is used the scans shall show that all measurement points selected for the ABM1 measurement meet the ambient and test system noise criterion in 6.2.1.

e. At each measurement location measure and record the undesired broadband audio magnetic signal (ABM2) as described in 6.3.4.3 with no audio signal applied (or digital zero applied, if appropriate) using A-weighting, and the half-band integrator. Calculate the ratio of the desired to undesired signal strength (i.e., signal quality).

f. Change the probe orientation to one of the two remaining orientations. At both measurement orientations, measure and record ABM1 using either a sine wave at 1025 Hz or a voice-like signal for the reference audio input signal.

g. Determine the category that properly classifies the signal quality.

5.4.3 Test System Validation

Validation Results (20dBm forward input power), System checks the specific test data please see Annex C.

Frequency	Input Power (dBm)	E-field Result (V/m)	Target Field (V/m)	Deviation (%)
850 MHz	20.0	223.12	231.9	-3.8
1900MHz	20.0	150.52	145.49	-3.5
Frequency	Input Power (dBm)	H-field Result (A/m)	Target Field (A/m)	Deviation (%)
850 MHz	20.0	0.429	0.45	-4.7
1900MHz	20.0	0.438	0.45	-2.7
Note: The tolerance limit of System validation $\pm 10\%$				

Note: Target value was referring to the Measured value in the calibration certificate of reference dipole.

T-coil system validation Results

Input Level (mV)	Axial Description	Magnetic Field (dB A/m)	Target Field (dB A/m)	Tolerance(%)
500	Axial	-14.39	-13.99	3
	Radial H	-21.23	-21.85	-2.8
	Radial V	-20.27	-20.95	-3.2
Note: The tolerance limit of System validation $\pm 10\%$				

Note: Target value was referring to the Measurement value in the calibration certificate of reference dipole.

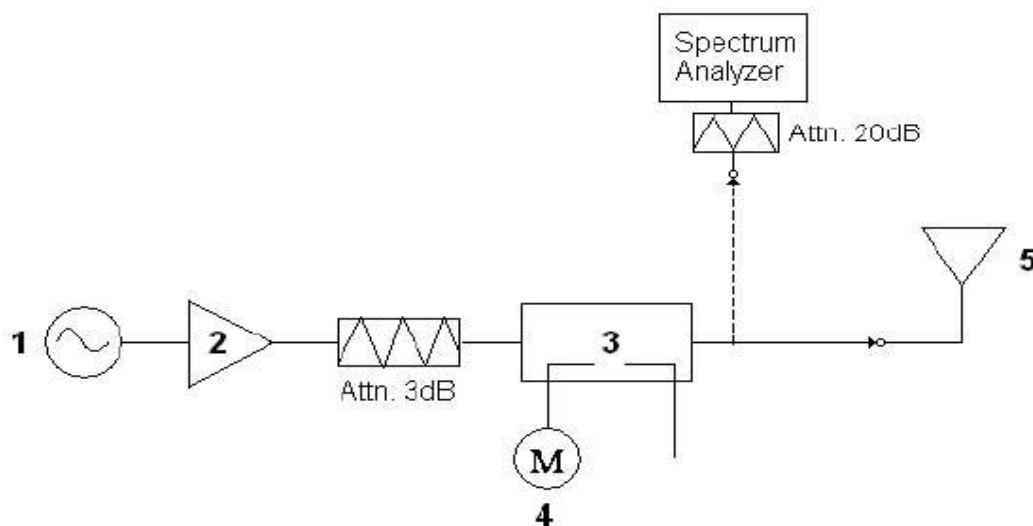
5.4.4 Probe Modulation Factor (PMF)

The Probe Modulation Factor (PMF) is defined as the ratio of the field readings for a CW and a modulated signal with the equivalent Field Envelope Peak as defined in the Standard. The field level of the test signals shall be more than 10 dB above the ambient level and the noise floor of the instrumentation being used. The ratio of the CW reading to that taken with a modulated field shall be applied to the readings taken of modulated fields of the specified type.

All voice modes for this device have been investigated in this section of the report.

The step was done according to the following procedure:

1. Fixing the probe in a set location relative to a field generating device.
2. Illuminate the probe with a CW signal at the intended measurement frequency.
3. Record the reading of the probe measurement system of the CW signal.
4. Determine the level of the CW signal being used to drive the field generating device.
5. Substitute a signal using the same modulation as that used by the intended WD for the CW signal.
6. Set the peak amplitude during transmission of the modulated signal to equal the amplitude of the CW signal.
7. Record the reading of the probe measurement system of the modulated signal.
8. The ratio of the CW to modulated signal reading is the modulation factor.
9. Repeat 2~8 steps at intended measurement frequency for both E and H field probe.



PMF measurement setup

PMF Summary:

Probe	Frequency (MHz)	Type of signal	E-Field (V/m)	PMF
E-Field Probe	835	GSM	624.58	2.88
		CW	223.12	
	1880	GSM	433.50	2.88
		CW	150.52	
H-Field Probe	835	GSM	1.235	2.88
		CW	0.429	
	1880	GSM	1.261	2.88
		CW	0.438	

Probe	Frequency (MHz)	Type of signal	E-Field (V/m)	PMF
E-Field Probe	835	WCDMA	223.12	1
		CW	223.12	
	1880	WCDMA	150.52	1
		CW	150.52	
H-Field Probe	835	WCDMA	0.429	1
		CW	0.429	
	1880	WCDMA	0.438	1
		CW	0.438	

Note: Modulation factor= E_{cw} / E_{mod} and similar for H.

6 CHARACTERISTICS OF THE TEST

6.1 Applicable Limit Regulations

Table 1 Telephone near-field categories in linear units (<960MHz)

Category	AWF (dB)	Limits for E-Field Emission (V/m)	Limits for H-Field Emission (A/m)
M1	0	631.0 - 1122.0	1.91 - 3.39
	-5	473.2 - 841.4	1.43 - 2.54
M2	0	354.8 - 631.0	1.07 - 1.91
	-5	266.1 - 473.2	0.80 - 1.43
M3	0	199.5 - 354.8	0.6 - 1.07
	-5	149.6 - 266.1	0.45 - 0.80
M4	0	<199.5	<0.60
	-5	<149.6	<0.45

Table 2 Telephone near-field categories in linear units (>960MHz)

Category	AWF (dB)	Limits for E-Field Emission (V/m)	Limits for H-Field Emission (A/m)
M1	0	199.5 - 354.8	0.6 - 1.07
	-5	149.6 - 266.1	0.45 - 0.8
M2	0	112.2 - 199.5	0.34 - 0.6
	-5	84.1 - 149.6	0.25 - 0.45
M3	0	63.1 - 112.2	0.19 - 0.34
	-5	47.3 - 84.1	0.15 - 0.25
M4	0	<63.1	<0.19
	-5	<47.3	<0.15

Table 3 T-Coil Mode Categories

Category	Telephone RF Parameter
	Wireless Device Signal Quality (Signal + Noise-to-noise ratio in dB)
T1	0 to 10 dB
T2	10 to 20 dB
T3	20 to 30 dB
T4	>30 dB

6.2 Applicable Measurement Standards

ANSI C63.19-2007: American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

FCC 47CFR § 20.19 American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids

It specifies the measurement method for demonstration of compliance with the HAC limits for such equipments.

7 LABORATORY ENVIRONMENT

Table 4: The Ambient Conditions during HAC Test

Temperature	Min. = 15 ° C, Max. = 30 ° C
Relative humidity	Min. = 30%, Max. = 70%
Ground system resistance	< 0.5 Ω
Ambient noise is checked and found very low and in compliance with requirement of standards.	
Reflection of surrounding objects is minimized and in compliance with requirement of standards.	

8 TEST RESULTS

8.1 Summary of Power Measurement Results

The power level results were listed in the following two tables:

Table 5: Conducted RF Power of GSM850

Band	GSM 850			GSM 1900		
Channel	128	190	251	512	661	810
Frequency	824.2	836.4	848.8	1850.2	1880.0	1909.8
GSM	31.58	32.35	33.16	30.31	30.47	29.20

Table 6: Conducted RF Power of WCDMA

Band	WCDMA 850			WCDMA 1900		
TX Channel	4132	4182	4233	9262	9400	9538
RX Channel	4357	4408	4458	9662	9800	9938
Frequency	826.4	836.4	846.6	1852.4	1880.0	1907.6
RMC 12.2K	23.52	23.60	23.58	23.35	23.52	22.90

8.2 Summary of Measurement Results

Table 7: RF Emission Values of the EUT

Temperature: 23.0~23.5°C, humidity: 62~64%.						
Band	Channel	AWF (dB)	Frequency (MHz)	Test Results		Category
				E-field (V/m)	H-field (A/m)	
GSM850	128	-5	824.2	76.66	0.09	M4
	190	-5	836.4	86.53	0.08	M4
	251	-5	848.8	85.56	0.09	M4
GSM1900	512	-5	1850.2	28.25	0.02	M4
	661	-5	1880.0	31.87	0.02	M4
	810	-5	1909.8	32.85	0.02	M4
WCDMA850	4132	0	826.4	30.38	0.07	M4
	4182	0	836.4	30.39	0.06	M4
	4233	0	846.6	30.48	0.07	M4
WCDMA1900	9262	0	1852.4	17.77	0.04	M4
	9400	0	1880.0	17.40	0.04	M4
	9538	0	1907.6	18.91	0.04	M4

Table 8: T-Coil Values of the EUT

Temperature: 23.0~23.5°C, humidity: 62~64%.						
Band	Channel	Frequency (MHz)	Test Results (dB)			Category
			Axial	Radial H	Radial V	
GSM850	190	836.6	34.10	26.47	22.72	T3
GSM1900	661	1880.0	34.20	28.35	24.31	T3
WCDMA850	4182	836.6	38.82	36.91	36.87	T4
WCDMA1900	9538	1907.6	37.80	37.00	34.59	T4

8.3 Conclusion

Both RF emission values and T-Coil values of this portable wireless device were measured in all cases requested by the relevant standards cited in Clause 6 of this report. All of the results were **below** exposure limits specified in the relevant standards.

9 Measurement Uncertainty

Table 9: Measurement Uncertainty of RF Emission Test

Uncertainty Component	Uncertainty value	Probe Dist.	Div	(Ci) E	(Ci) H	Std. Unc.(+-%)	
						E	H
Measurement System							
Probe calibration	6.00	N	1.000	1	1	6.00	6.00
Axial Isotropy	2.02	R	1.732	1	1	1.17	1.17
Sensor Displacement	14.30	R	1.732	1	0.217	8.26	1.79
Boundary effect	2.50	R	1.732	1	1	0.87	0.87
Phantom Boundary effect	6.89	R	1.732	1	0	3.52	0.00
Linearity	2.58	R	1.732	1	1	1.49	1.49
Scaling to PMR Calibration	9.02	N	1.000	1	1	9.02	9.02
System Detection Limit	1.30	R	1.732	1	1	0.75	0.75
Readout Electronics	0.25	R	1.732	1	1	0.14	0.14
Response Time	1.23	R	1.732	1	1	0.71	0.71
Integration Time	2.15	R	1.732	1	1	1.24	1.24
RF Ambient Conditions	2.03	R	1.732	1	1	1.17	1.17
RF Reflections	9.09	R	1.732	1	1	5.25	5.25
Probe positioner	0.63	N	1.000	1	0.71	0.63	0.45
Probe positioning	3.12	N	1.000	1	0.71	3.12	2.22
Extrapolation and Interpolation	1.18	R	1.732	1	1	0.68	0.68
Uncertainties of the EUT							
Test sample positioning Vertical	2.73	R	1.732	1	0.71	1.58	1.12
Test sample positioning Lateral	1.19	R	1.732	1	1	0.69	0.69
Device Holder and Phantom	2.20	N	1.000	1	1	2.20	2.20
Power Drift	4.08	R	1.732	1	1	2.36	2.36
Phantom and Setup Related							
Phantom Thickness	2.00	N	1.000	1	0.6	2.00	1.20
Combined Std. Uncertainty(k=1)						16.18	13.25
Expanded Uncertainty on Power						32.35	26.50
Expanded Uncertainty on Field						16.18	13.25

Note:

N-Nominal

R-Rectangular

Div.- Divisor used to obtain standard uncertainty

Table 10: Measurement Uncertainty of T-Coil Test

No.	Uncertainty Component	Type	Uncertainty Value (%)	Probability Distribution	k	ci	Standard Uncertainty (%) $u_i(\%)$	Degree of freedom ν_{eff} or ν_i
Measurement System								
1	—Probe Calibration	B	6	N	3	1	3.5	∞
2	—Axial isotropy	B	4.7	R	1.732	0.5	4.3	∞
3	—Hemispherical Isotropy	B	9.4	R	1.732	0.5	4.3	∞
4	—Boundary Effect	B	11.0	R	1.732	1	6.4	∞
5	—Linearity	B	4.7	R	1.732	1	2.7	∞
6	—System Detection Limits	B	1.0	R	1.732	1	0.6	∞
7	—Probe Coil Sensitivity	B	0.49	R	1.732	1	0.28	∞
8	—Response Time	B	0.00	R	1.732	1	0.00	∞
9	—Integration Time	B	0.00	R	1.732	1	0.00	∞
10	—RF Ambient Conditions	B	3.0	R	1.732	1	1.73	∞
11	—Probe Position Mechanical tolerance	B	0.4	R	1.732	1	0.2	∞
12	—Probe Position with respect to Phantom Shell	B	2.9	R	1.732	1	1.7	∞

Uncertainties of the DUT								
13	—Position of the DUT	A	4.8	N	3	1	4.8	5
14	—Holder of the DUT	A	7.1	N	3	1	7.1	5
15	—Repeatability of the WD	B	5.0	R	1.732	1	2.9	∞
Acoustic noise								
16	—Acoustic noise	B	1.0	R	1.732	1	0.6	∞
21	—Cable loss	B	0.46	N	1.732	1	0.46	∞
Combined Standard Uncertainty				RSS			17.26	42.33
Expanded uncertainty (Confidence interval of 95 %)				K=2			34.52	

10 MAIN TEST INSTRUMENTS

No	EQUIPMENT	TYPE	Series No.	Due Date
1	E-Field Probe	SATIMO/SCE	SN 02/12 EPH34	2014/04/04
2	H-Field Probe	SATIMO/SCH	SN 02/12 HPH45	2014/04/04
3	T-Coil Probe	SATIMO/STCOIL	SN 24/11 TCP23	2014/04/04
4	Dipole	SATIMO/SIDB835	SN 18/12 DHA37	2014/04/04
5	Dipole	SATIMO/SIDB1900	SN 18/12 DHB42	2014/04/04
6	TMFS	SATIMO/STMFS	SN 22/12 TMFS15	2014/04/04
7	Vector Network Analyzer	ZVB8	1145.1010.08	2014/06/13
8	Amplifier	Nucletudes	143060	2014/04/04
9	Power Meter	NRVS	1020.1809.02	2014/06/13
10	Multimeter	Keithley - 2000	4014020	2014/04/04
11	Power Sensor	NRV-Z4	100069	2014/06/10
12	Wireless Communication Test Set	CMU200	A0304212	2014/06/10
13	PC	AOC	A130501338	N/A

ANNEX A

of

CCIC-SET

CONFORMANCE TEST REPORT FOR

HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS

SET2014-00659

Toughshield devices ltd

Toughshield

Type Name: R750

Hardware Version: S097M001P110

Software Version: R750_VER_2.0_01035_20131114

TEST LAYOUT

This Annex consists of 2 pages

Date of Report: 2014-01-24

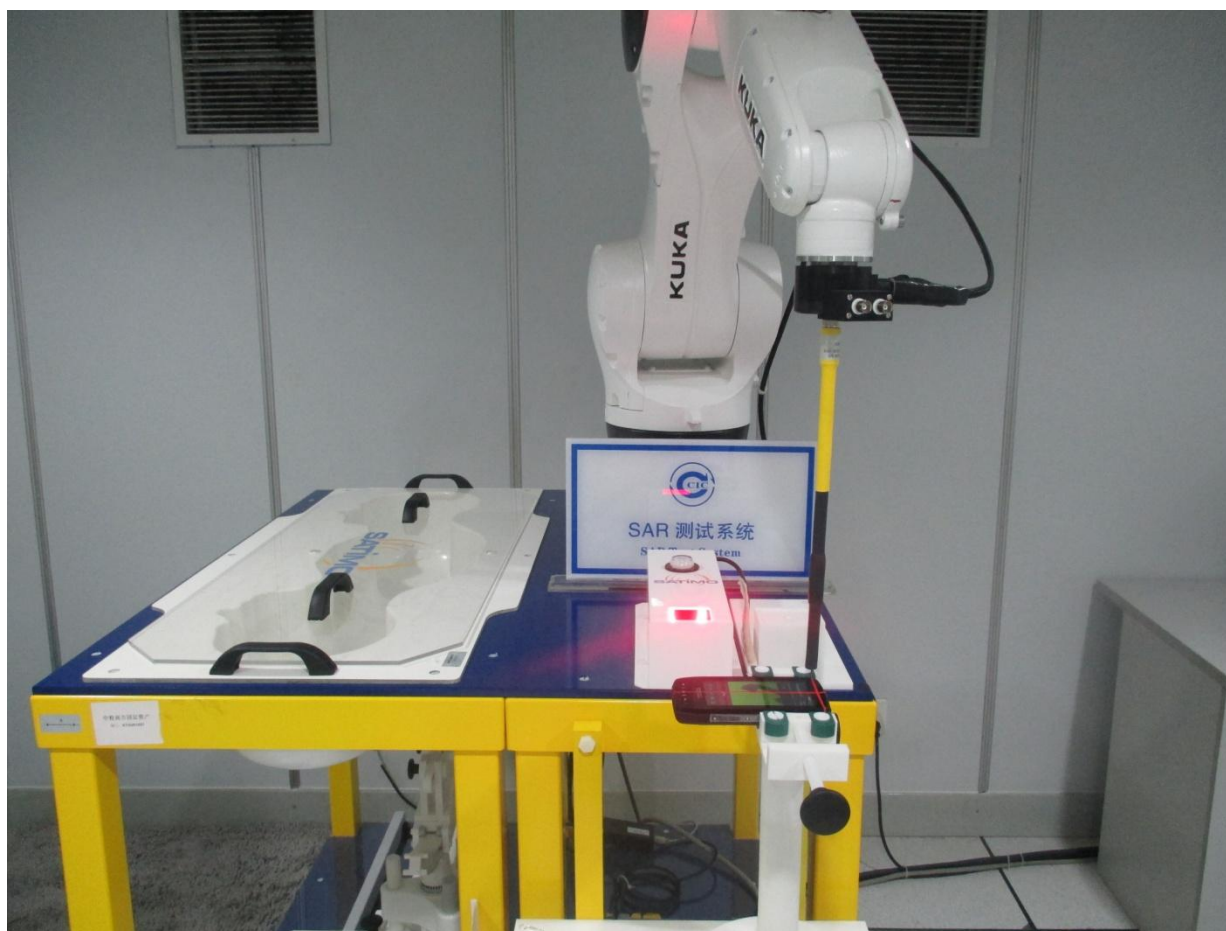


Fig.1 HAC Test Configuration

ANNEX B

of

CCIC-SET

CONFORMANCE TEST REPORT FOR

HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS

SET2014-00659

Toughshield

Type Name: R750

Hardware Version: S097M001P110

Software Version: R750_VER_2.0_01035_20131114

Sample Photographs

This Annex consists of 3 pages

Date of Report: 2014-01-24

1. Appearance



Appearance and size (obverse)



Appearance and size (reverse)

2. Inside



3. Battery



ANNEX C

of

CCIC-SET

CONFORMANCE TEST REPORT FOR

HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS

SET2014-00659

Toughshield

Type Name: R750

Hardware Version: S097M001P110

Software Version: R750_VER_2.0_01035_20131114

System Performance Check Data

This Annex consists of 54 pages

Date of Report: 2014-01-24

System Performance Check (E, 835MHz)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

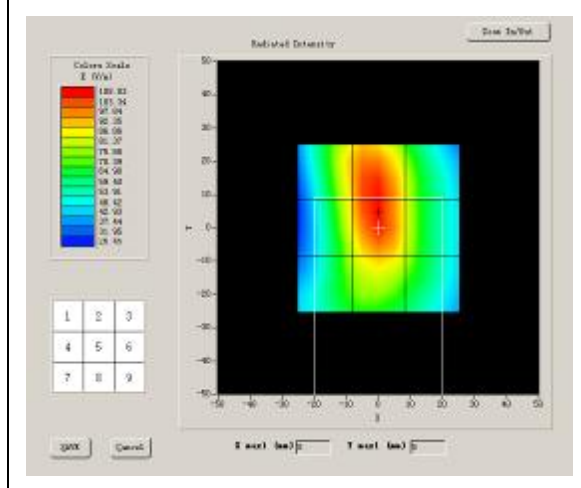
A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	CUSTOM (CW835)
Channel	Low
Signal	Duty Cycle: 1

B. HAC Measurement Results

Frequency (MHz): 835.000000

SURFACE HAC



Power Drift:-1.4%

Probe Modulation Factor= 1.00

Maximum value of total field = 223.12 V/m

E in V/m

Grid 1: 221.51	Grid 2: 223.12	Grid 3: 212.56
Grid 4: 212.69	Grid 5: 216.00	Grid 6: 199.98
Grid 7: 201.13	Grid 8: 194.18	Grid 9: 196.51

System Performance Check (H, 835MHz)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

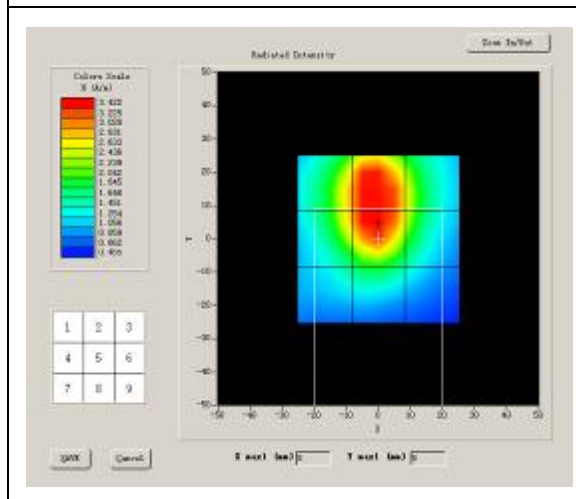
A. Experimental conditions.

Grid size (mm x mm)	20.0, 40.0
Step (mm)	5
Band	CW835
Channel	Middle
Signal	CW

B.. HAC Measurement Results

Frequency (MHz): 835.000000

SURFACE HAC



Power Drift:-4.0%

Probe Modulation Factor= 1.00

Maximum value of total field = 0.429 A/m;

H in A/m

Grid 1: 0.302	Grid 2: 0.421	Grid 3: 0.336
Grid 4: 0.381	Grid 5: 0.429	Grid 6: 0.332
Grid 7: 0.370	Grid 8: 0.400	Grid 9: 0.239

System Performance Check (E, 1900MHz)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

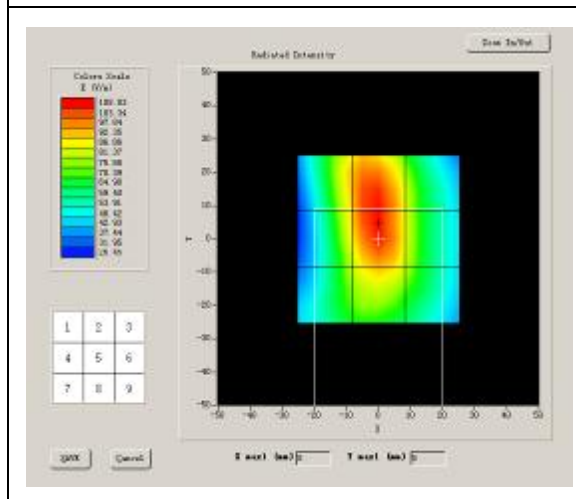
A. Experimental conditions.

Grid size (mm x mm)	20.0, 80.0
Step (mm)	5
Band	CUSTOM (CW1900)
Channel	Middle
Signal	Duty Cycle: 1

B. HAC Measurement Results

Frequency (MHz): 1900.000000

SURFACE HAC



Power Drift:-1.4%

Probe Modulation Factor= 1.00

Maximum value of total field = 150.52V/m;

E in V/m

Grid 1: 135.51	Grid 2: 148.33	Grid 3: 120.11
Grid 4: 141.64	Grid 5: 150.52	Grid 6: 132.95
Grid 7: 131.52	Grid 8: 138.62	Grid 9: 116.77

System Performance Check (H, 1900MHz)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

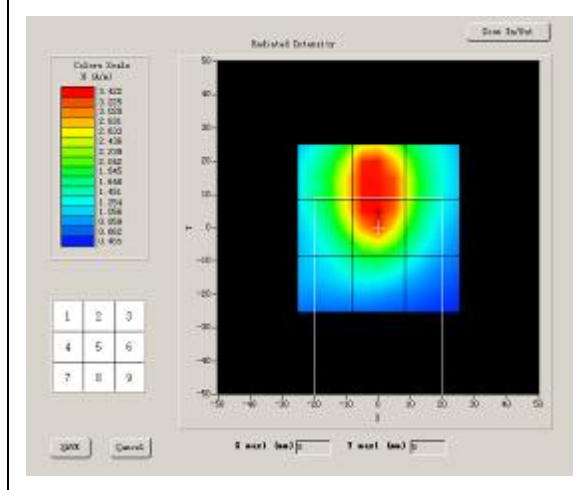
A. Experimental conditions.

Grid size (mm x mm)	20.0, 80.0
Step (mm)	5
Band	CUSTOM (CW1900)
Channel	Middle
Signal	Duty Cycle: 1

B. HAC Measurement Results

Frequency (MHz): 1900.000000

SURFACE HAC



Probe Modulation Factor= 1.00

Maximum value of total field = 0.438 A/m;

H in A/m

Grid 1: 0.424	Grid 2: 0.434	Grid 3: 0.384
Grid 4: 0.437	Grid 5: 0.438	Grid 6: 0.415
Grid 7: 0.432	Grid 8: 0.415	Grid 9: 0.361

Test Results (GSM850, E, Low Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

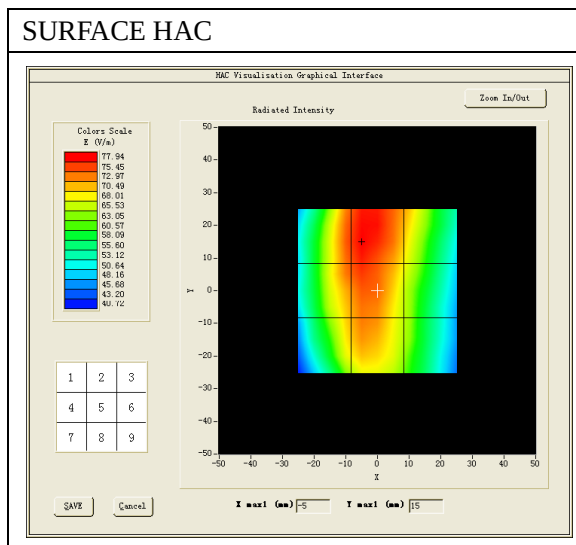
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	Low
Signal	GSM

B. HAC Measurement Results

Lower Band (Channel 128):

Frequency (MHz): 824.200000

SURFACE HAC



Probe Modulation Factor = 2.880000

Maximum value of total field = 76.66 V/m

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

E in V/m

Grid 1: 76.43	Grid 2: 78.02	Grid 3: 70.07
Grid 4: 75.45	Grid 5: 76.66	Grid 6: 66.42
Grid 7: 71.26	Grid 8: 73.31	Grid 9: 63.86

Test Results (GSM850, H, Low Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

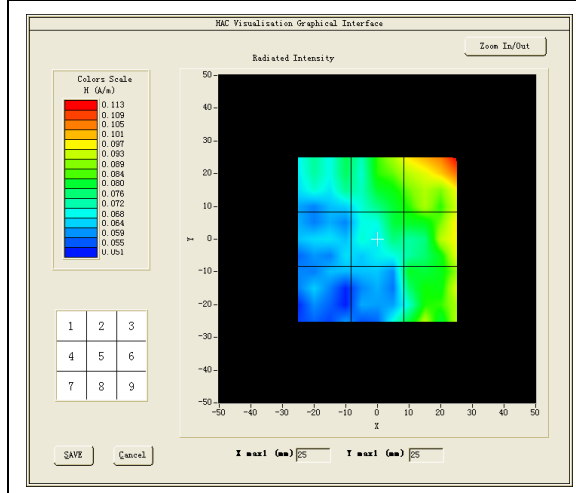
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	CUSTOM (CW835)
Channel	Low
Signal	GSM

B. HAC Measurement Results

Lower Band (Channel 128):

Frequency (MHz): 824.200000

SURFACE HAC



Probe Modulation Factor = 2.880000

Maximum value of total field = 0.09 A/m

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

H in A/m

Grid 1: 0.08	Grid 2: 0.10	Grid 3: 0.11
Grid 4: 0.07	Grid 5: 0.08	Grid 6: 0.10
Grid 7: 0.06	Grid 8: 0.08	Grid 9: 0.09

Test Results (GSM850, E, Middle Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

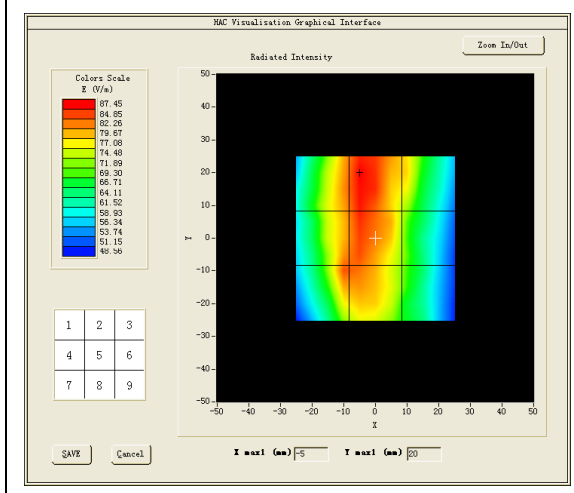
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	Middle
Signal	GSM

B. HAC Measurement Results

Middle Band (Channel 189):

Frequency (MHz): 836.400000

SURFACE HAC



Probe Modulation Factor = 2.880000

Maximum value of total field = 86.53 V/m

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

E in V/m

Grid 1: 84.10	Grid 2: 87.79	Grid 3: 78.46
Grid 4: 84.13	Grid 5: 86.53	Grid 6: 72.56
Grid 7: 84.72	Grid 8: 84.33	Grid 9: 70.45

Test Results (GSM850, H, Middle Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

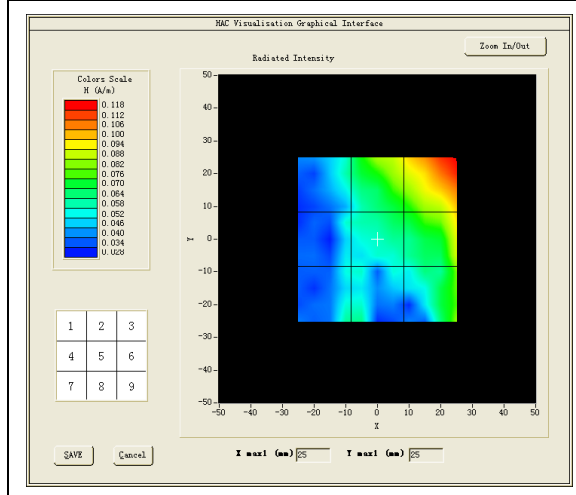
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	Middle
Signal	GSM

B. HAC Measurement Results

Middle Band (Channel 189):

Frequency (MHz): 836.400000

SURFACE HAC



Probe Modulation Factor = 2.880000

Maximum value of total field = 0.08 A/m

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

H in A/m

Grid 1: 0.06	Grid 2: 0.10	Grid 3: 0.12
Grid 4: 0.06	Grid 5: 0.07	Grid 6: 0.10
Grid 7: 0.06	Grid 8: 0.06	Grid 9: 0.08

Test Results (GSM850, E, High Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

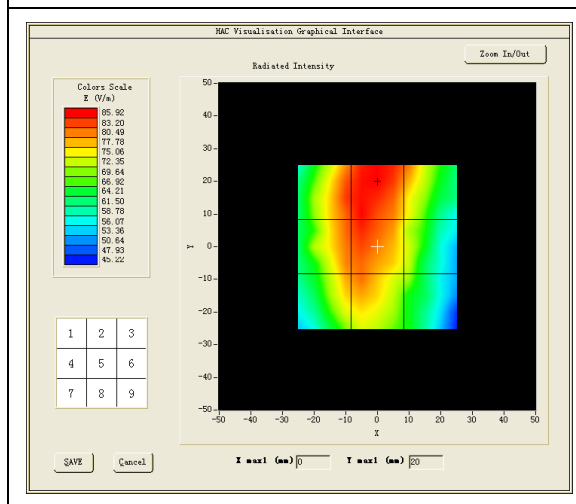
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	High
Signal	GSM

B. HAC Measurement Results

Higher Band (Channel 251):

Frequency (MHz): 848.600000

SURFACE HAC



Probe Modulation Factor = 2.880000

Maximum value of total field = 85.56 V/m

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

E in V/m

Grid 1: 84.88	Grid 2: 86.15	Grid 3: 80.63
Grid 4: 83.72	Grid 5: 85.56	Grid 6: 73.85
Grid 7: 80.67	Grid 8: 81.37	Grid 9: 71.06

Test Results (GSM850, H, High Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

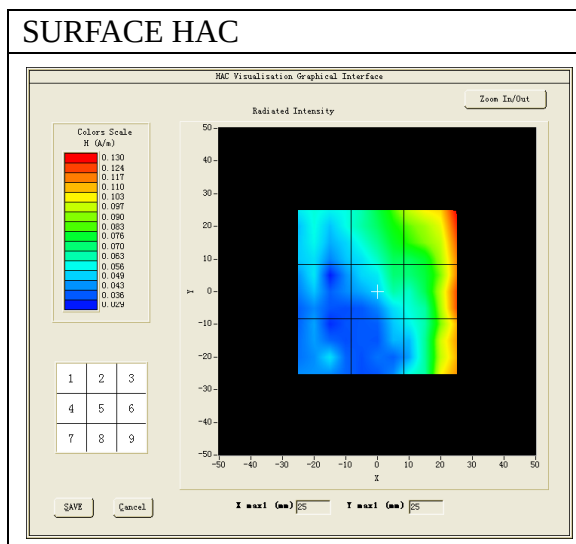
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	High
Signal	GSM

B. HAC Measurement Results

Higher Band (Channel 251):

Frequency (MHz): 848.600000

SURFACE HAC



Probe Modulation Factor = 2.880000

Maximum value of total field = 0.09 A/m

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

H in A/m

Grid 1: 0.06	Grid 2: 0.09	Grid 3: 0.13
Grid 4: 0.05	Grid 5: 0.07	Grid 6: 0.12
Grid 7: 0.05	Grid 8: 0.05	Grid 9: 0.11

Test Results (GSM1900, E, Low Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

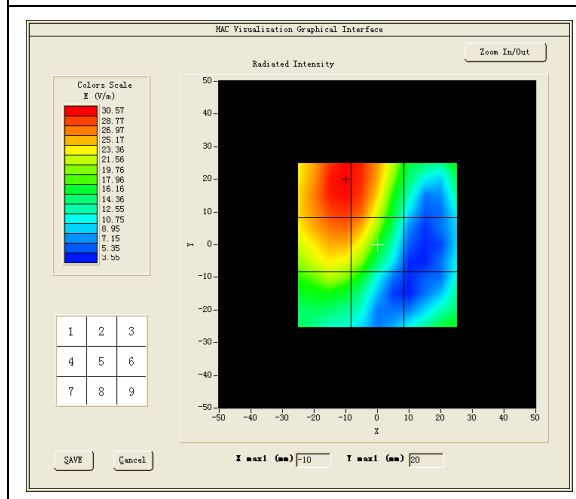
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM1900
Channel	Low
Signal	GSM

B. HAC Measurement Results

Lower Band (Channel 512):

Frequency (MHz): 1850.200000

SURFACE HAC



Probe Modulation Factor = 2.880000

Maximum value of total field = 28.25 V/m

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

E in V/m

Grid 1: 30.65	Grid 2: 30.23	Grid 3: 16.53
Grid 4: 28.97	Grid 5: 28.25	Grid 6: 10.57
Grid 7: 22.18	Grid 8: 19.67	Grid 9: 17.88

Test Results (GSM1900, H, Low Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

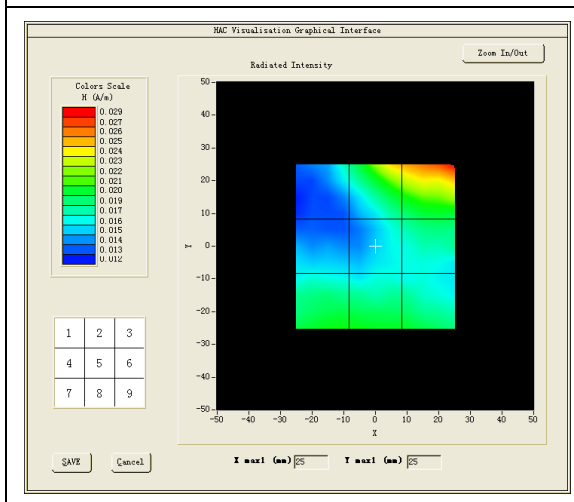
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM1900
Channel	Low
Signal	TDMA

B. HAC Measurement Results

Lower Band (Channel 512):

Frequency (MHz): 1850.200000

SURFACE HAC



Probe Modulation Factor = 2.880000

Maximum value of total field = 0.02 A/m

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

H in A/m

Grid 1: 0.02	Grid 2: 0.03	Grid 3: 0.03
Grid 4: 0.02	Grid 5: 0.02	Grid 6: 0.02
Grid 7: 0.02	Grid 8: 0.02	Grid 9: 0.02

Test Results (GSM1900, E, Middle Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

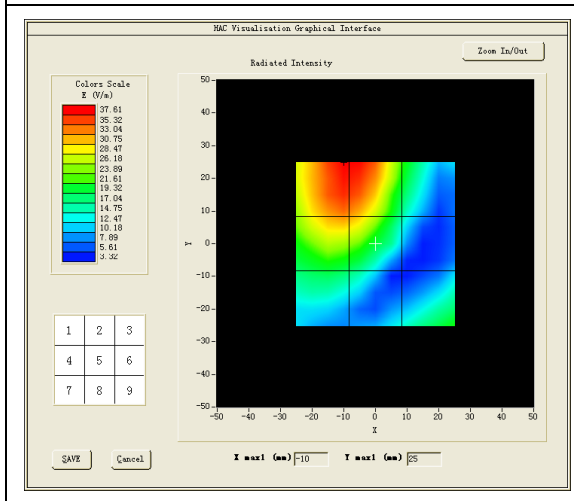
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM1900
Channel	Middle
Signal	GSM

B. HAC Measurement Results

Middle Band (Channel 661):

Frequency (MHz): 1880.000000

SURFACE HAC



Probe Modulation Factor = 2.880000

Maximum value of total field = 31.87 V/m

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

E in V/m

Grid 1: 37.79	Grid 2: 37.73	Grid 3: 20.25
Grid 4: 33.04	Grid 5: 31.87	Grid 6: 13.23
Grid 7: 19.28	Grid 8: 17.04	Grid 9: 20.95

Test Results (GSM1900, H, Middle Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

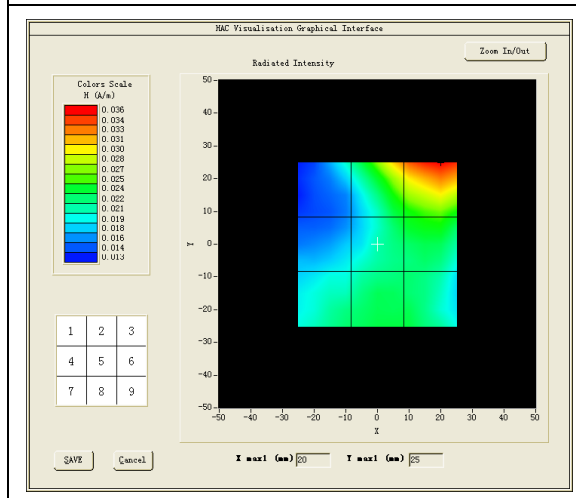
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM1900
Channel	Middle
Signal	TDMA

B. HAC Measurement Results

Middle Band (Channel 661):

Frequency (MHz): 1880.000000

SURFACE HAC



Probe Modulation Factor = 2.880000

Maximum value of total field = 0.02 A/m

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

H in A/m

Grid 1: 0.02	Grid 2: 0.03	Grid 3: 0.04
Grid 4: 0.02	Grid 5: 0.02	Grid 6: 0.03
Grid 7: 0.02	Grid 8: 0.02	Grid 9: 0.02

Test Results (GSM1900, E, High Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

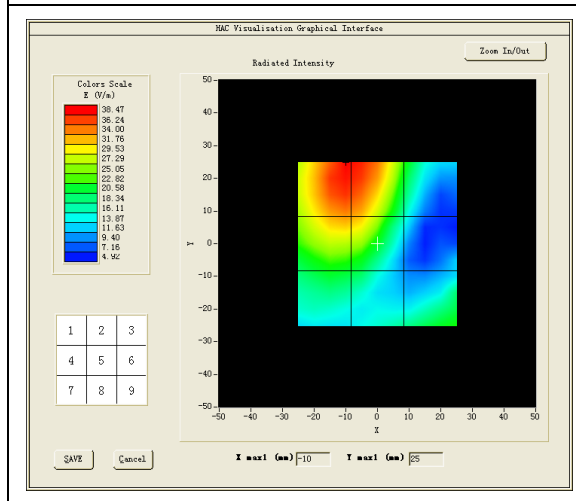
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM1900
Channel	High
Signal	TDMA

B. HAC Measurement Results

Higher Band (Channel 810):

Frequency (MHz): 1909.800000

SURFACE HAC



Probe Modulation Factor = 2.880000

Maximum value of total field = 32.85 V/m

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

E in V/m

Grid 1: 38.52	Grid 2: 38.07	Grid 3: 20.96
Grid 4: 33.51	Grid 5: 32.85	Grid 6: 13.44
Grid 7: 21.89	Grid 8: 20.57	Grid 9: 22.57

Test Results (GSM1900, H, High Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

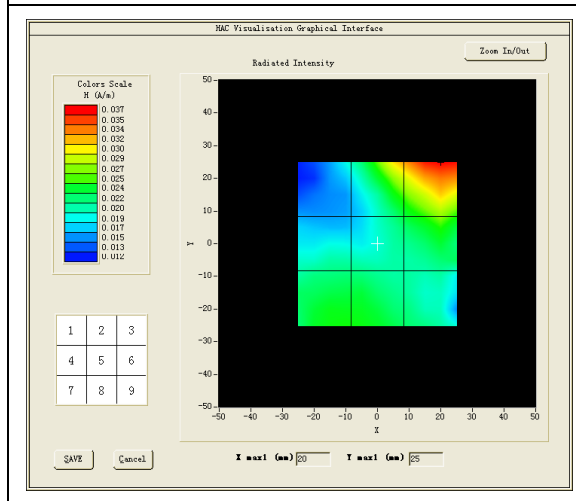
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM1900
Channel	High
Signal	GSM

B. HAC Measurement Results

Higher Band (Channel 810):

Frequency (MHz): 1909.800000

SURFACE HAC



Probe Modulation Factor = 2.880000

Maximum value of total field = 0.02 A/m

Hearing Aid Near-Field Category: M4 (AWF -5 dB)

H in A/m

Grid 1: 0.02	Grid 2: 0.03	Grid 3: 0.04
Grid 4: 0.02	Grid 5: 0.02	Grid 6: 0.03
Grid 7: 0.02	Grid 8: 0.02	Grid 9: 0.02

Test Results (WCDMA850, E, Low Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

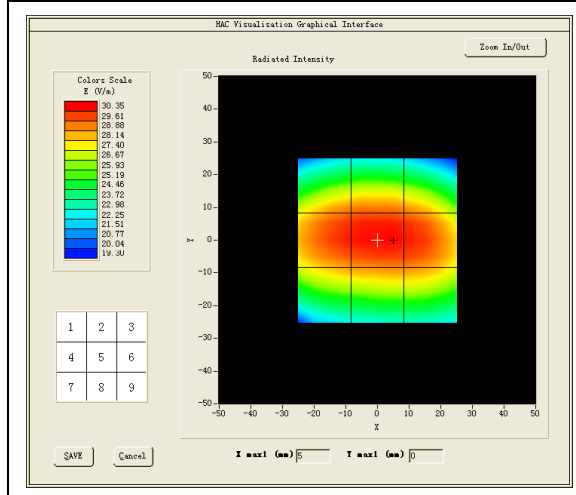
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA850
Channel	Low
Signal	CDMA

B. HAC Measurement Results

Lower Band (Channel 4132):

Frequency (MHz): 826.400000

SURFACE HAC



Probe Modulation Factor = 1.000000

Maximum value of total field = 30.38 V/m

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

E in V/m

Grid 1: 28.79	Grid 2: 28.97	Grid 3: 28.46
Grid 4: 30.12	Grid 5: 30.38	Grid 6: 30.04
Grid 7: 28.64	Grid 8: 28.93	Grid 9: 28.86

Test Results (WCDMA850, H, Low Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

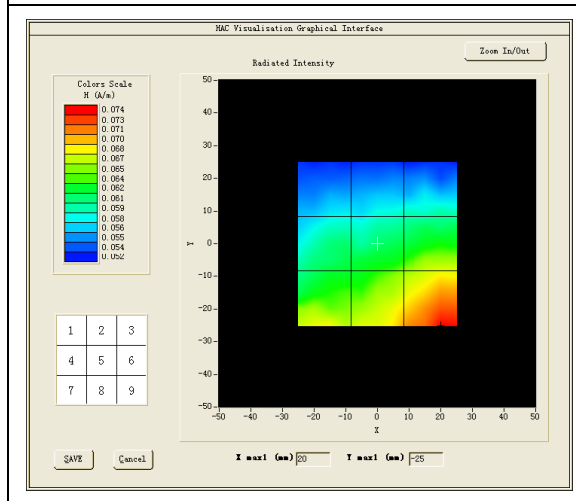
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA850
Channel	Low
Signal	CDMA

B. HAC Measurement Results

Lower Band (Channel 4132):

Frequency (MHz): 826.400000

SURFACE HAC



Probe Modulation Factor = 1.000000

Maximum value of total field = 0.07 A/m

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

H in A/m

Grid 1: 0.06	Grid 2: 0.06	Grid 3: 0.06
Grid 4: 0.06	Grid 5: 0.07	Grid 6: 0.07
Grid 7: 0.07	Grid 8: 0.07	Grid 9: 0.07

Test Results (WCDMA850, E, Middle Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

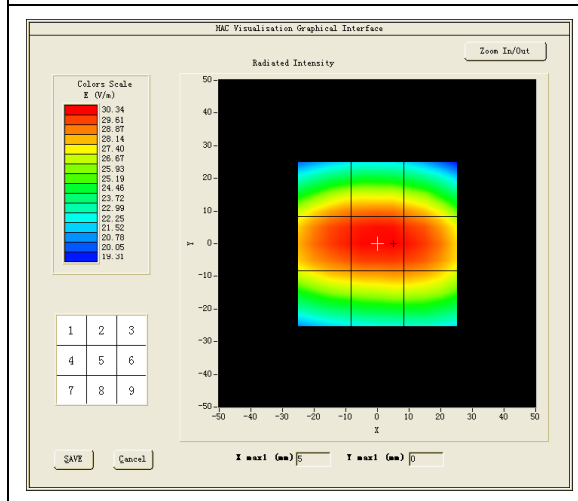
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA850
Channel	Middle
Signal	CDMA

B. HAC Measurement Results

Middle Band (Channel 4182):

Frequency (MHz): 836.400000

SURFACE HAC



Probe Modulation Factor = 1.000000

Maximum value of total field = 30.39 V/m

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

E in V/m

Grid 1: 28.87	Grid 2: 29.05	Grid 3: 28.55
Grid 4: 30.16	Grid 5: 30.39	Grid 6: 30.10
Grid 7: 28.71	Grid 8: 28.98	Grid 9: 28.88

Test Results (WCDMA850, H, Middle Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

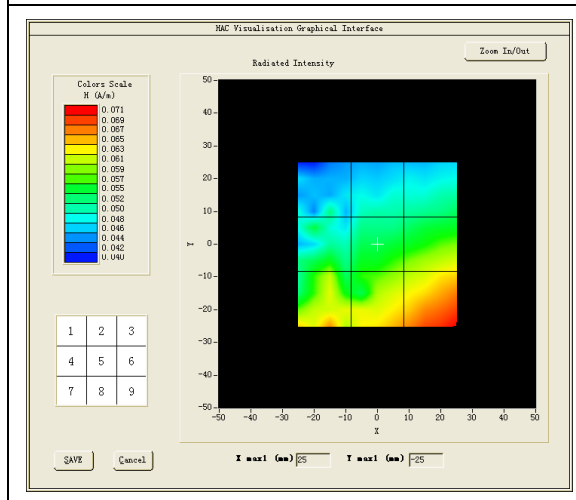
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA850
Channel	Middle
Signal	CDMA

B. HAC Measurement Results

Middle Band (Channel 4182):

Frequency (MHz): 836.400000

SURFACE HAC



Probe Modulation Factor = 1.000000

Maximum value of total field = 0.06 A/m

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

H in A/m

Grid 1: 0.05	Grid 2: 0.05	Grid 3: 0.05
Grid 4: 0.06	Grid 5: 0.06	Grid 6: 0.06
Grid 7: 0.07	Grid 8: 0.07	Grid 9: 0.07

Test Results (WCDMA850, E, High Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

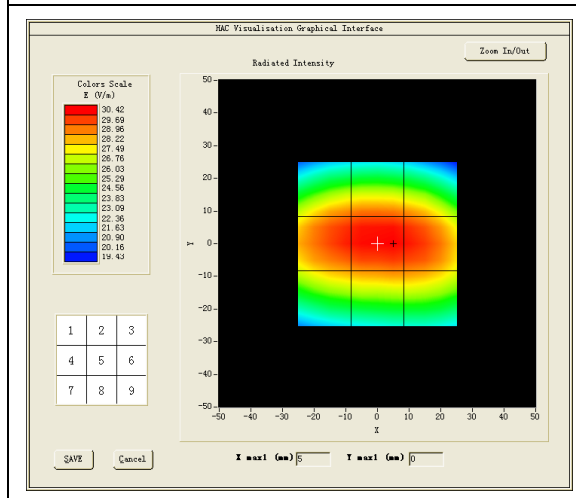
Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA850
Channel	High
Signal	CDMA

B. HAC Measurement Results

Higher Band (Channel 4233):

Frequency (MHz): 846.600000

SURFACE HAC



Probe Modulation Factor = 1.000000

Maximum value of total field = 30.48 V/m

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

E in V/m

Grid 1: 28.88 Grid 2: 29.08 Grid 3: 28.63

Grid 4: 30.23 Grid 5: 30.48 Grid 6: 30.19

Grid 7: 28.68 Grid 8: 29.05 Grid 9: 28.94

Test Results (WCDMA850, H, High Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

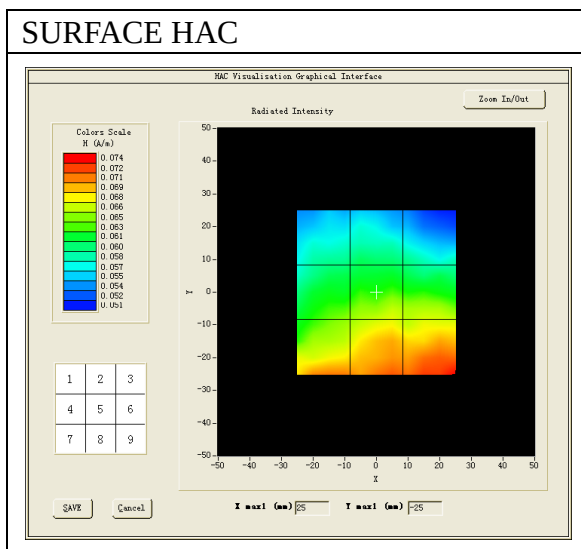
A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA850
Channel	High
Signal	CDMA

B. HAC Measurement Results

Higher Band (Channel 4233):

Frequency (MHz): 846.600000



Probe Modulation Factor = 1.000000

Maximum value of total field = 0.07 A/m

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

H in A/m

Grid 1: 0.06	Grid 2: 0.06	Grid 3: 0.06
Grid 4: 0.06	Grid 5: 0.07	Grid 6: 0.07
Grid 7: 0.07	Grid 8: 0.07	Grid 9: 0.07

Test Results (WCDMA1900, E, Low Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

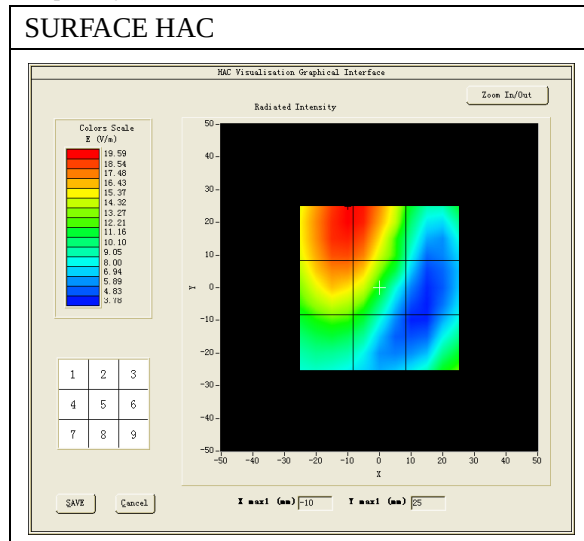
A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA1900
Channel	Low
Signal	CDMA

B. HAC Measurement Results

Higher Band (Channel 9262):

Frequency (MHz): 1852.400000



Probe Modulation Factor = 1.000000

Maximum value of total field = 17.77 V/m

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

E in V/m

Grid 1: 19.71	Grid 2: 19.62	Grid 3: 11.20
Grid 4: 18.29	Grid 5: 17.77	Grid 6: 7.80
Grid 7: 13.44	Grid 8: 12.41	Grid 9: 12.97

Test Results (WCDMA1900, H, Low Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

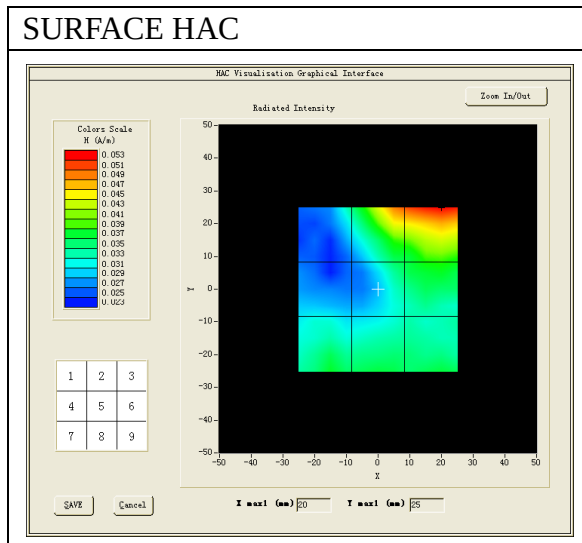
A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA1900
Channel	Low
Signal	WCDMA

B. HAC Measurement Results

Higher Band (Channel 9262):

Frequency (MHz): 1852.400000



Probe Modulation Factor = 1.000000

Maximum value of total field = 0.04 A/m

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

H in A/m

Grid 1: 0.03	Grid 2: 0.05	Grid 3: 0.05
Grid 4: 0.03	Grid 5: 0.04	Grid 6: 0.04
Grid 7: 0.04	Grid 8: 0.04	Grid 9: 0.04

Test Results (WCDMA1900, E, Middle Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

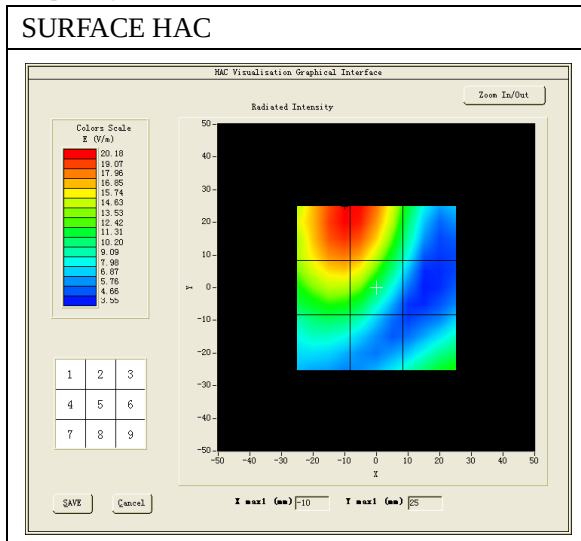
A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA1900
Channel	Middle
Signal	CDMA

B. HAC Measurement Results

Higher Band (Channel 9400):

Frequency (MHz): 1880.000000



Probe Modulation Factor = 1.000000

Maximum value of total field = 17.40 V/m

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

E in V/m

Grid 1: 20.36	Grid 2: 20.30	Grid 3: 11.35
Grid 4: 17.82	Grid 5: 17.40	Grid 6: 7.75
Grid 7: 11.29	Grid 8: 10.30	Grid 9: 12.49

Test Results (WCDMA1900, H, Middle Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

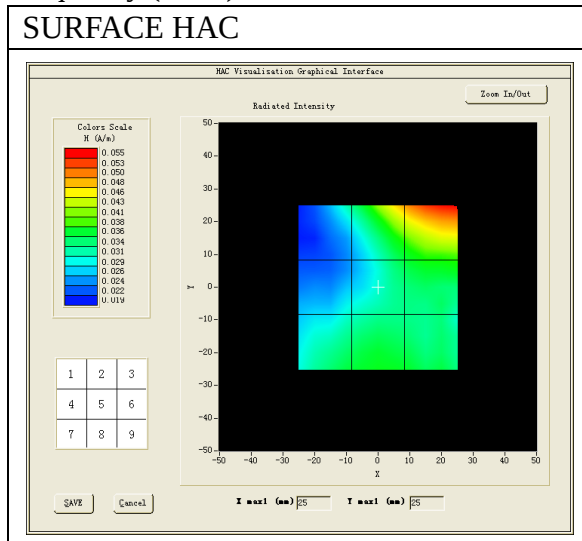
A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA1900
Channel	Middle
Signal	CDMA

B. HAC Measurement Results

Higher Band (Channel 9400):

Frequency (MHz): 1880.000000



Probe Modulation Factor = 1.000000

Maximum value of total field = 0.04 A/m

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

H in A/m

Grid 1: 0.03	Grid 2: 0.05	Grid 3: 0.05
Grid 4: 0.03	Grid 5: 0.04	Grid 6: 0.04
Grid 7: 0.04	Grid 8: 0.04	Grid 9: 0.04

Test Results (WCDMA1900, E, High Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

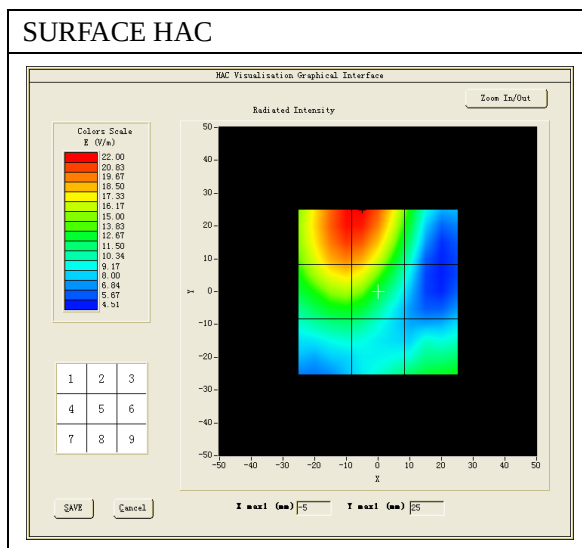
A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA1900
Channel	High
Signal	CDMA

B. HAC Measurement Results

Higher Band (Channel 9538):

Frequency (MHz): 1907.600000



Probe Modulation Factor = 1.000000

Maximum value of total field = 18.91 V/m

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

E in V/m

Grid 1: 22.12	Grid 2: 22.14	Grid 3: 13.65
Grid 4: 19.24	Grid 5: 18.91	Grid 6: 9.62
Grid 7: 12.19	Grid 8: 11.86	Grid 9: 13.37

Test Results (WCDMA1900, H, High Channel)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

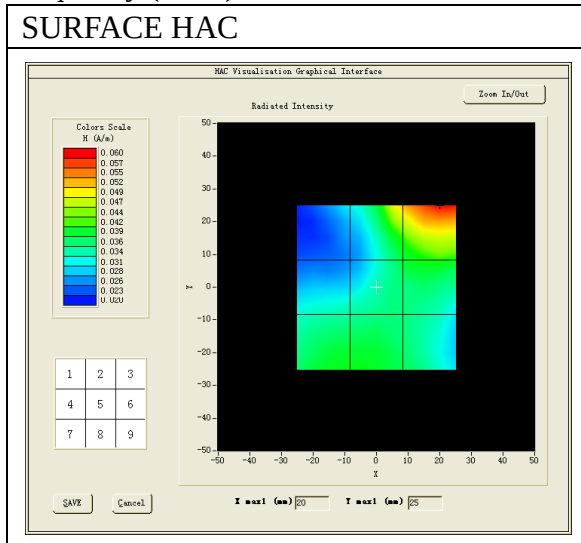
A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA1900
Channel	High
Signal	CDMA

B. HAC Measurement Results

Higher Band (Channel 9538):

Frequency (MHz): 1907.600000



Probe Modulation Factor = 1.000000

Maximum value of total field = 0.04 A/m

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

H in A/m

Grid 1: 0.03	Grid 2: 0.05	Grid 3: 0.06
Grid 4: 0.03	Grid 5: 0.04	Grid 6: 0.04
Grid 7: 0.04	Grid 8: 0.04	Grid 9: 0.04

Test Results (GSM850, T-Coil)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Scanning Height (mm)	15.0
Band	GSM850

B. HAC Measurement Results Frequency (MHz): 836.600000

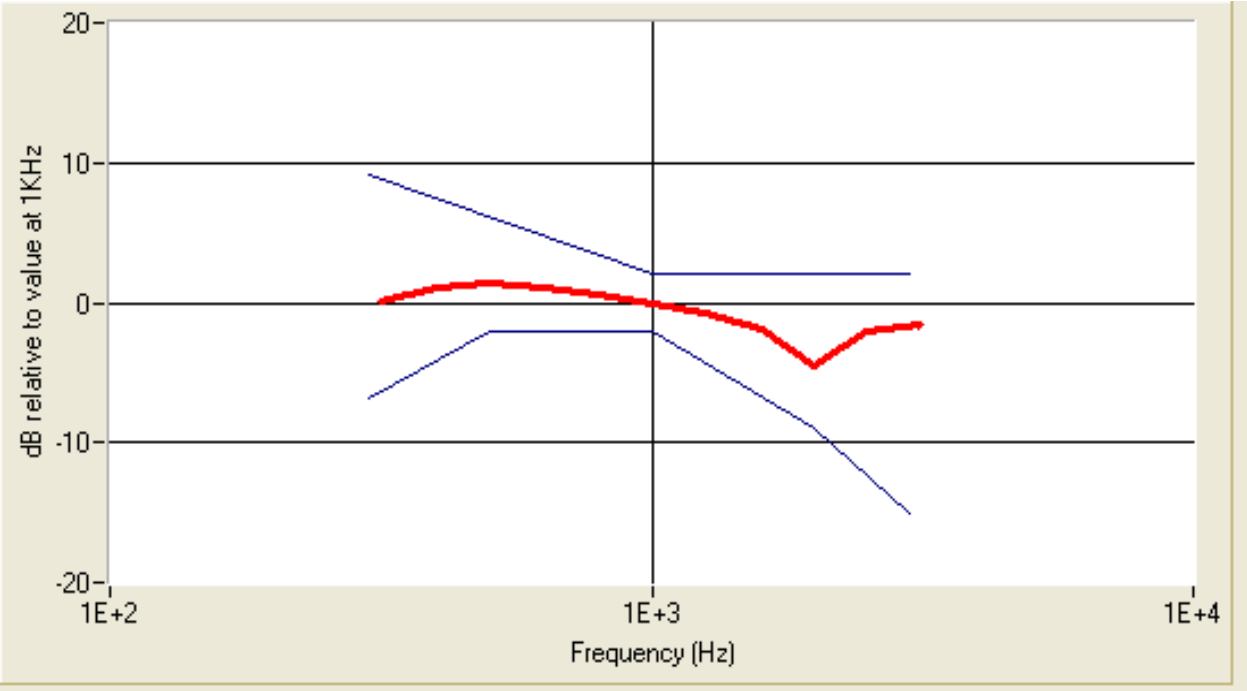
Raw Data Results

	Axial			Radial H						Radial V					
	128	189	250	128		189		250		128		189		250	
	Max	Max	Max	Left	Right	Left	Right	Left	Right	Up	Down	Up	Down	Up	Down
ABM1, dBA/m	NULL	-1.29	NULL	NULL	NULL	-9.41	-8.91	NULL	NULL	NULL	NULL	-10.06	-9.29	NULL	NULL
ABM2, dBA/m	NULL	-35.28	NULL	NULL	NULL	-39.00	-35.17	NULL	NULL	NULL	NULL	-35.58	-31.79	NULL	NULL
Ambient noise, dBA/m	-59.53	-59.53	-59.53	-59.99	-59.99	-59.99	-59.99	-59.99	-59.99	-56.73	-56.73	-56.73	-56.73	-56.73	-56.73
Freq Reponse Margin (dB)	-	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-
S+N/N(dB)	NULL	34.10	NULL	NULL	NULL	29.64	26.47	NULL	NULL	NULL	NULL	25.76	22.72	NULL	NULL
S+N/N per orientation (dB)	34.10			26.47						22.72					

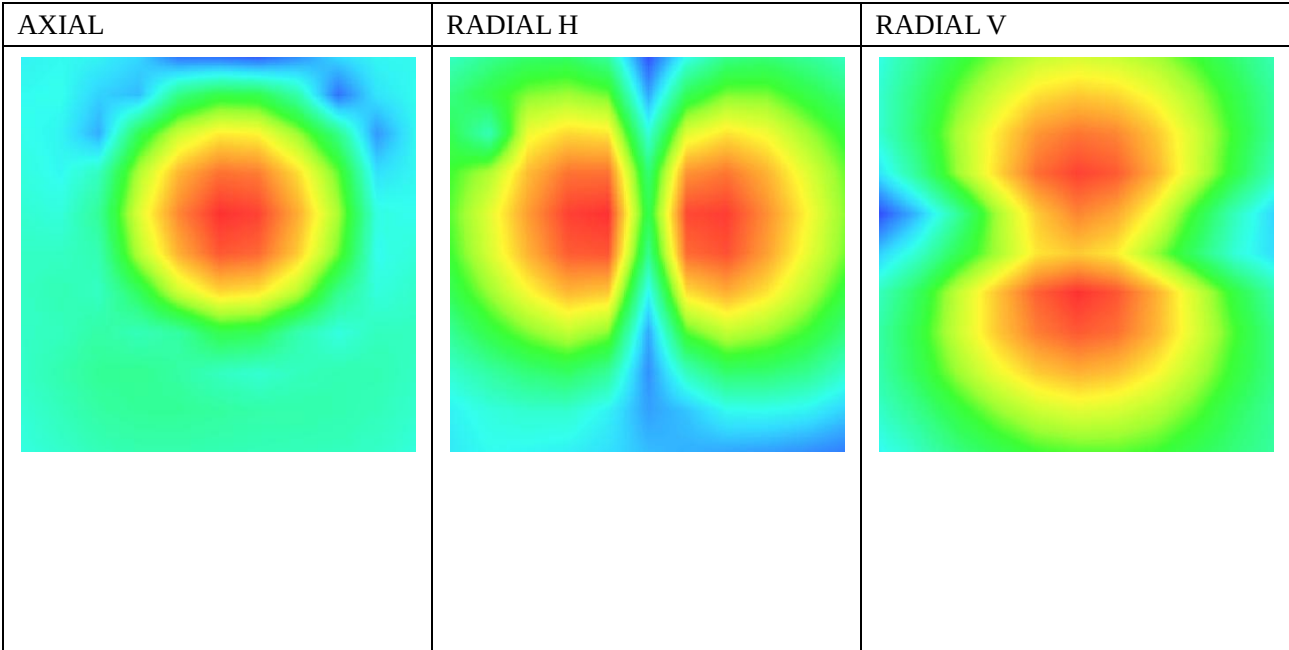
Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBa/m	-	dBa/m	-	Pass/Fail
7.3.1	GSM	GSM850	Intensity, Axial	-18	Max	-1.29	-	PASS
7.3.1			Intensity, RadialH	-18	Right side	-9.41	-	PASS
				-18	Left side	-8.91	-	PASS
7.3.1			Intensity, RadialV	-18	Upper side	-10.06	-	PASS
				-18	Lower side	-9.29	-	PASS
7.3.4			Signal to noise/noise, Axial	20	Max	34.10	T4	PASS
7.3.4			Signal to noise/noise, RadialH	20	Right side	29.64	T3	PASS
				20	Left side	26.47	T3	PASS
7.3.4			Signal to noise/noise, RadialV	20	Upper side	25.76	T3	PASS
				20	Lower side	22.72	T3	PASS
7.3.4			Frequency reponse, Axial	0	-	2.00	-	PASS

Magnetic field frequency response (field that exceeds -15 dB)



T.Coil Scan Overlay Magnetic Field Distributions



Test Results (GSM1900, T-Coil)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Scanning Height (mm)	15.0
Band	GSM1900

B. HAC Measurement Results Frequency (MHz): 1880.000000

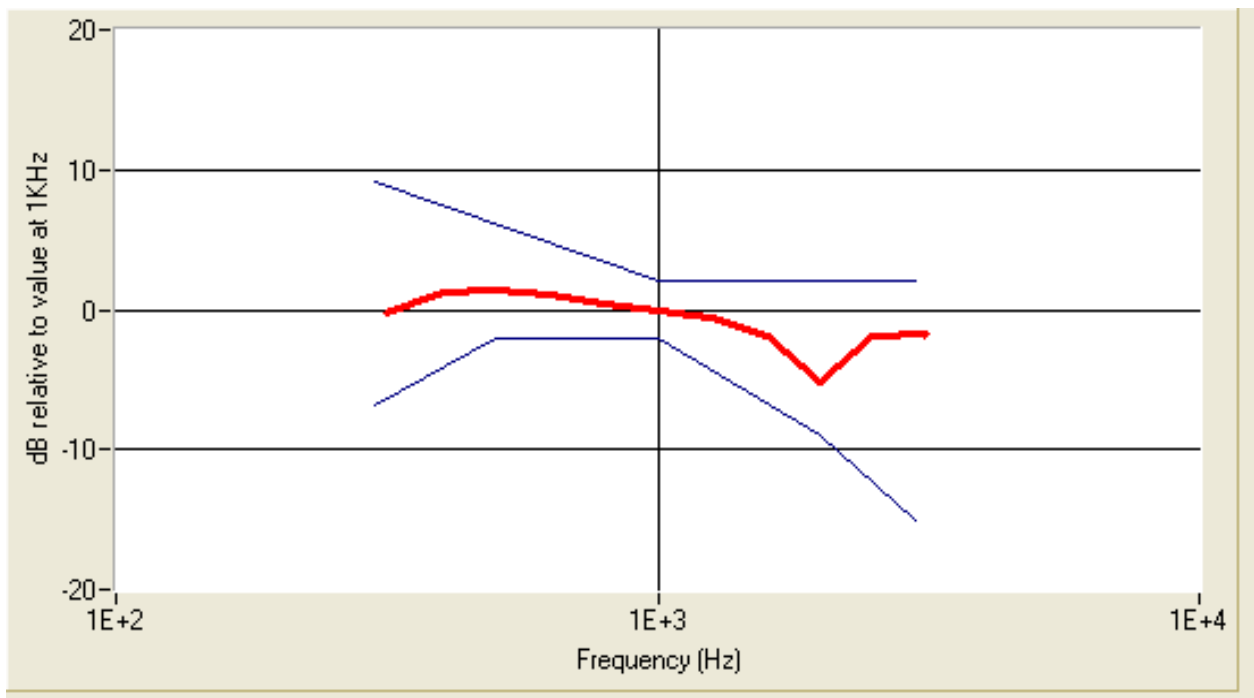
Raw Data Results

	Axial			Radial H						Radial V					
	513	661	809	513		661		809		513		661		809	
	Max	Max	Max	Left	Right	Left	Right	Left	Right	Up	Down	Up	Down	Up	Down
ABM1, dBA/m	NULL	-1.30	NULL	NULL	NULL	-9.32	-8.84	NULL	NULL	NULL	NULL	-9.88	-9.04	NULL	NULL
ABM2, dBA/m	NULL	-35.72	NULL	NULL	NULL	-40.64	-37.07	NULL	NULL	NULL	NULL	-37.32	-33.35	NULL	NULL
Ambient noise, dBA/m	-59.53	-59.53	-59.53	-59.99	-59.99	-59.99	-59.99	-59.99	-59.99	-56.73	-56.73	-56.73	-56.73	-56.73	-56.73
Freq Reponse Margin (dB)	-	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-
S+N/N(dB)	NULL	34.20	NULL	NULL	NULL	31.45	28.35	NULL	NULL	NULL	NULL	27.64	24.31	NULL	NULL
S+N/N per orientation (dB)	34.20			28.35						24.31					

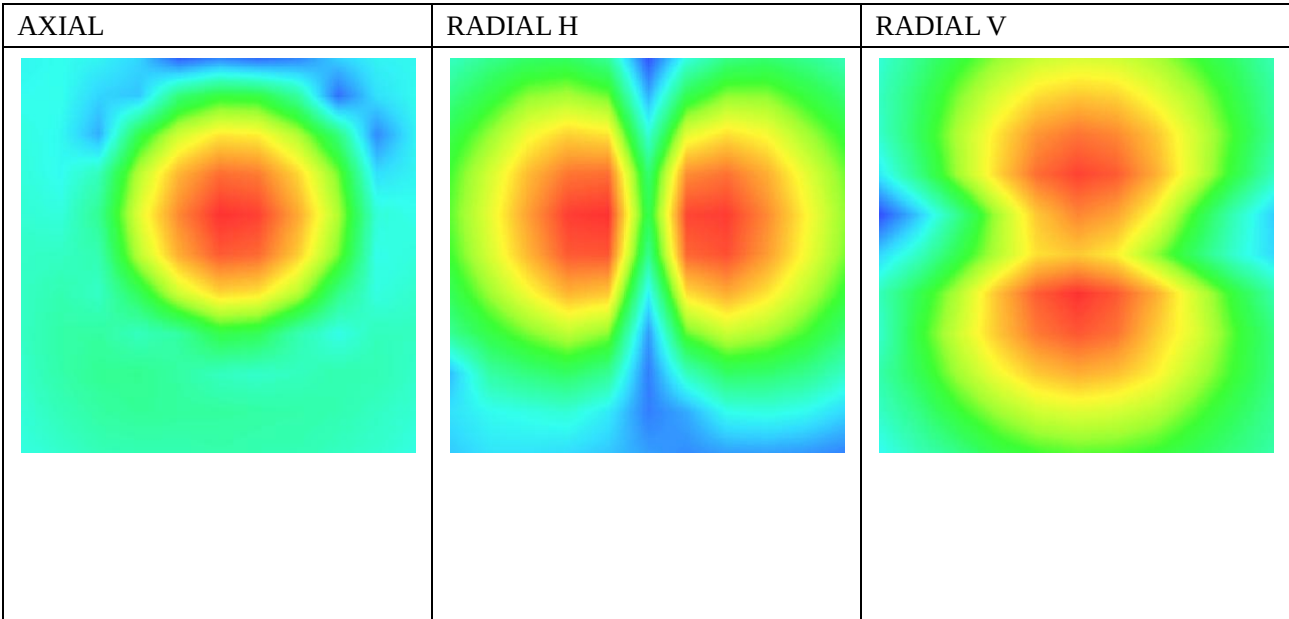
Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBa/m	-	dBa/m	-	Pass/Fail
7.3.1	GSM	GSM1900	Intensity, Axial	-18	Max	-1.30	-	PASS
7.3.1			Intensity, RadialH	-18	Right side	-9.32	-	PASS
				-18	Left side	-8.84	-	PASS
7.3.1			Intensity, RadialV	-18	Upper side	-9.88	-	PASS
				-18	Lower side	-9.04	-	PASS
7.3.4			Signal to noise/noise, Axial	20	Max	34.20	T4	PASS
7.3.4			Signal to noise/noise, RadialH	20	Right side	31.45	T4	PASS
				20	Left side	28.35	T3	PASS
7.3.4			Signal to noise/noise, RadialV	20	Upper side	27.64	T3	PASS
				20	Lower side	24.31	T3	PASS
7.3.4			Frequency reponse, Axial	0	-	2.00	-	PASS

Magnetic field frequency response (field that exceeds -15 dB)



T.Coil Scan Overlay Magnetic Field Distributions



Test Results (WCDMA850, T-Coil)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Scanning Height (mm)	15.0
Band	WCDMA850

B. HAC Measurement Results Frequency (MHz): 836.600000

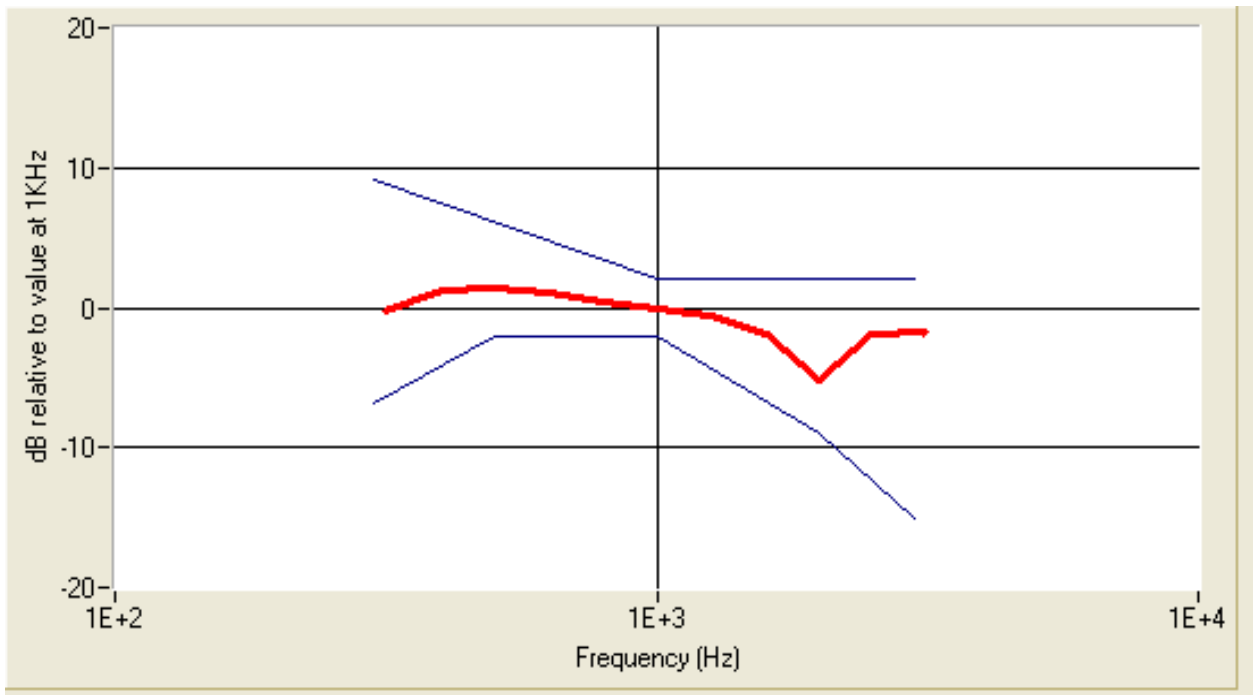
Raw Data Results

	Axial			Radial H						Radial V					
	4132	4182	4233	4132		4182		4233		4132		4182		4233	
	Max	Max	Max	Left	Right	Left	Right	Left	Right	Up	Down	Up	Down	Up	Down
ABM1, dBA/m	NULL	-1.13	NULL	NULL	NULL	-9.17	-8.81	NULL	NULL	NULL	NULL	-9.67	-9.12	NULL	NULL
ABM2, dBA/m	NULL	-40.02	NULL	NULL	NULL	-46.75	-45.74	NULL	NULL	NULL	NULL	-48.49	-46.09	NULL	NULL
Ambient noise, dBA/m	-59.53	-59.53	-59.53	-59.99	-59.99	-59.99	-59.99	-59.99	-59.99	-56.73	-56.73	-56.73	-56.73	-56.73	-56.73
Freq Reponse Margin (dB)	-	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-
S+N/N(dB)	NULL	38.82	NULL	NULL	NULL	37.72	36.91	NULL	NULL	NULL	NULL	38.74	36.87	NULL	NULL
S+N/N per orientation (dB)	38.82			36.91						36.87					

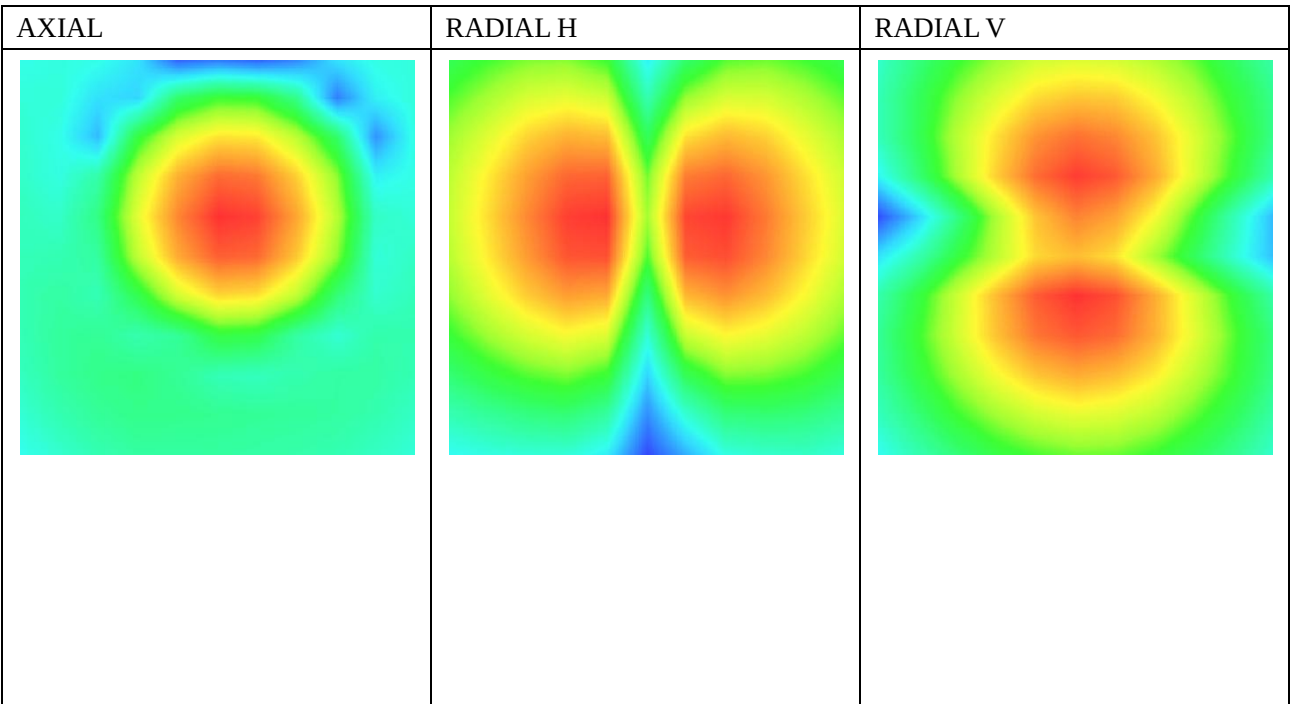
Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1	WCDMA	WCDMA850	Intensity, Axial	-18	Max	-1.13	-	PASS
7.3.1			Intensity, RadialH	-18	Right side	-9.17	-	PASS
				-18	Left side	-8.81	-	PASS
7.3.1			Intensity, RadialV	-18	Upper side	-9.67	-	PASS
				-18	Lower side	-9.12	-	PASS
7.3.4			Signal to noise/noise, Axial	20	Max	38.82	T4	PASS
7.3.4			Signal to noise/noise, RadialH	20	Right side	37.72	T4	PASS
				20	Left side	36.91	T4	PASS
7.3.4			Signal to noise/noise, RadialV	20	Upper side	38.74	T4	PASS
				20	Lower side	36.87	T4	PASS
7.3.4			Frequency reponse, Axial	0	-	2.00	-	PASS

Magnetic field frequency response (field that exceeds -15 dB)



T.Coil Scan Overlay Magnetic Field Distributions



Test Results (WCDMA1900, T-Coil)

Date of measurement: 22/01/2014

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Scanning Height (mm)	15.0
Band	WCDMA1900

B. HAC Measurement Results

Frequency (MHz): 1907.600000

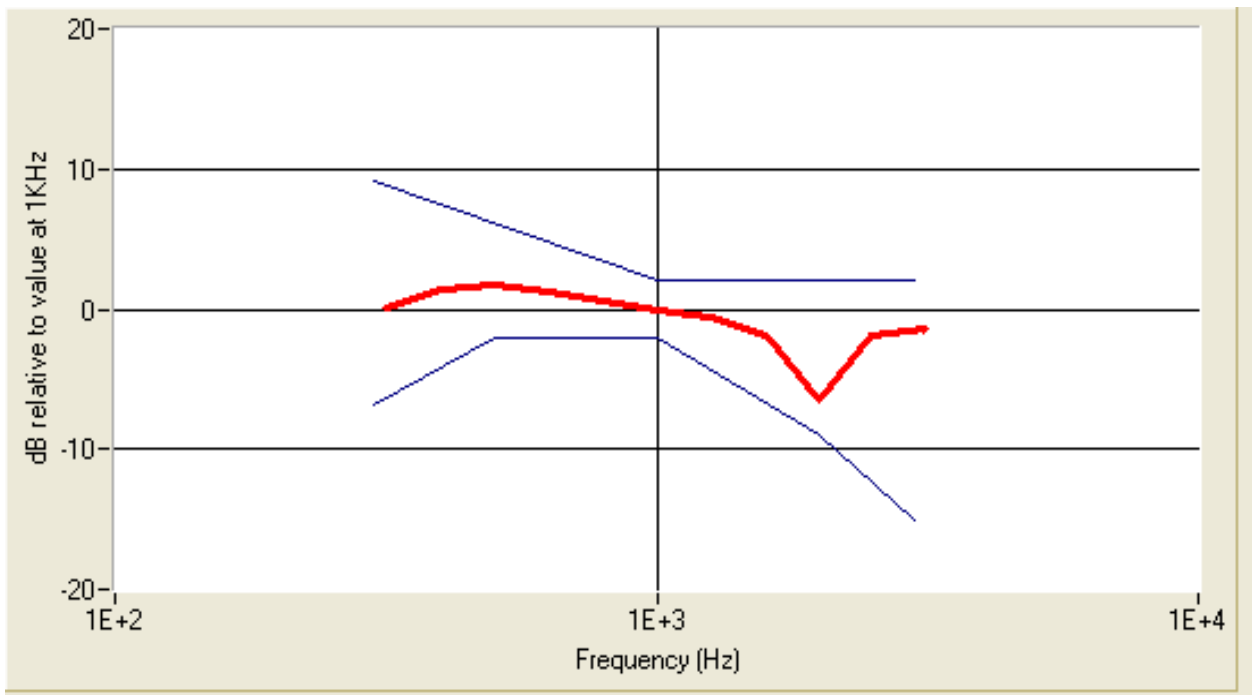
Raw Data Results

	Axial			Radial H						Radial V					
	9262	9400	9538	9262		9400		9538		9262		9400		9538	
	Max	Max	Max	Left	Right	Left	Right	Left	Right	Up	Down	Up	Down	Up	Down
ABM1, dBA/m	NULL	-1.43	NULL	NULL	NULL	-9.32	-8.82	NULL	NULL	NULL	NULL	-9.91	-9.28	NULL	NULL
ABM2, dBA/m	NULL	-39.02	NULL	NULL	NULL	-47.66	-45.83	NULL	NULL	NULL	NULL	-48.62	-43.84	NULL	NULL
Ambient noise, dBA/m	-59.53	-59.53	-59.53	-59.99	-59.99	-59.99	-59.99	-59.99	-59.99	-56.73	-56.73	-56.73	-56.73	-56.73	-56.73
Freq Reponse Margin (dB)	-	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-
S+N/N(dB)	NULL	37.80	NULL	NULL	NULL	38.38	37.00	NULL	NULL	NULL	NULL	38.74	34.59	NULL	NULL
S+N/N per orientation (dB)	37.80			37.00						34.59					

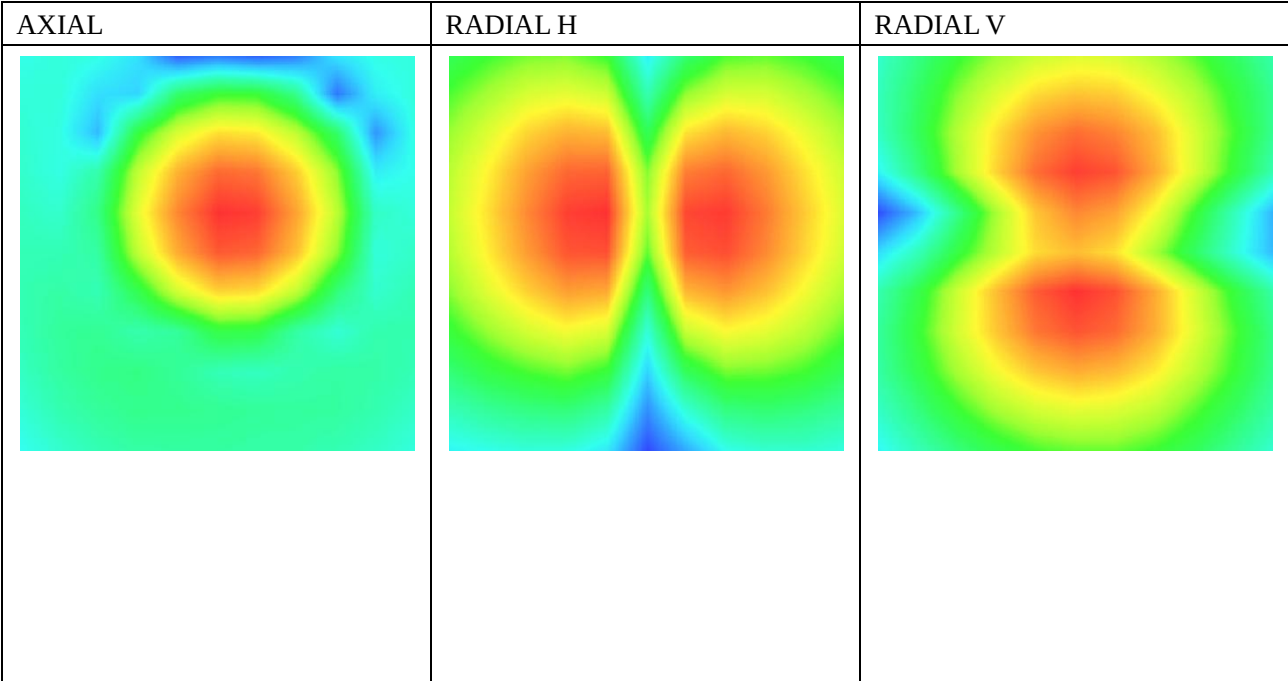
Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBa/m	-	dBa/m	-	Pass/Fail
7.3.1	WCDMA	WCDMA1900	Intensity, Axial	-18	Max	-1.43	-	PASS
7.3.1			Intensity, RadialH	-18	Right side	-9.32	-	PASS
				-18	Left side	-8.82	-	PASS
7.3.1			Intensity, RadialV	-18	Upper side	-9.91	-	PASS
				-18	Lower side	-9.28	-	PASS
7.3.4			Signal to noise/noise, Axial	20	Max	37.80	T4	PASS
7.3.4			Signal to noise/noise, RadialH	20	Right side	38.38	T4	PASS
				20	Left side	37.00	T4	PASS
7.3.4			Signal to noise/noise, RadialV	20	Upper side	38.74	T4	PASS
				20	Lower side	34.59	T4	PASS
7.3.4			Frequency reponse, Axial	0	-	2.00	-	PASS

Magnetic field frequency response (field that exceeds -15 dB)



T.Coil Scan Overlay Magnetic Field Distributions



ANNEX D

of

CCIC-SET

CONFORMANCE TEST REPORT FOR

HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS

SET2014-00659

Toughshield

Type Name: R750

Hardware Version: S097M001P110

Software Version: R750_VER_2.0_01035_20131114

Calibration Certificate of Probe and Dipoles

This Annex consists of 57 pages

Date of Report: 2014-01-22

E-Field Probe Calibration Certificate



COMOHAC E-Field Probe Calibration Report

Ref: ACR.96.10.13.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT TESTING
(SHENZHEN) CO.,LTD
ELECTRONIC TESTING BUILDING,SHAHE ROAD, XILI
TOWN SHENZHEN,P.R.CHINA**

**SATIMO COMOHAC E-FIELD PROBE
SERIAL NO.: SN 02/12 EPH34**

**Calibrated at SATIMO US
2105 Barrett Park Dr. - Kennesaw, GA 30144**



04/05/13

Summary:

This document presents the method and results from an accredited COMOHAC E-Field Probe calibration performed in SATIMO USA using the CALIBAIR test bench, for use with a SATIMO COMOHAC system only. All calibration results are traceable to national metrology institutions.



COMOHAC E-FIELD PROBE CALIBRATION REPORT

Ref ACR.96.10.13.SATU.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	4/5/2013	<i>JS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	4/5/2013	<i>JS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	4/5/2013	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	Shenzhen EMC-united Co., Ltd

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	4/5/2013	Initial release

Page: 2/8

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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC E FIELD PROBE
Manufacturer	Satimo
Model	SCE
Serial Number	SN 02/12 EPH34
Product Condition (new / used)	New
Frequency Range of Probe	0.7GHz-2.5GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=1.201 MΩ Dipole 2: R2=1.193 MΩ Dipole 3: R3=0.994 MΩ

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

Satimo's COMOHAC E field Probes are built in accordance to the ANSI C63.19 and IEEE 1309 standards.



Figure 1 – Satimo COMOHAC E field Probe

Probe Length	330 mm
Length of Individual Dipoles	3.3 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	5 mm
Distance between dipoles / probe extremity	3 mm

3 MEASUREMENT METHOD

All methods used to perform the measurements and calibrations comply with the ANSI C63.19 and IEEE 1309 standards.

3.1 LINEARITY

The linearity was determined using a standard dipole with the probe positioned 10 mm above the dipole. The input power of the dipole was adjusted from -15 to 36 dBm using a 1dB step (to cover the range 2V/m to 1000A/m).

3.2 SENSITIVITY

The sensitivity factors of the three dipoles were determined using the waveguide method outlined in the fore mentioned standards.

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3.3 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole. The probe was rotated along its main axis from 0 - 360 degrees in 15 degree steps.

3.4 PROBE MODULATION RESPONSE

The modulation factor was determined by illuminating the probe with a reference wave from a standard dipole 10 mm away, applying first a CW signal and then a modulated signal (both at same power level). The modulation factor is the ratio, in linear units, of the CW to modulated signal reading.

4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEEE 1528 and IEC/CEI 62209 standards were followed to generate the measurement uncertainty associated with an E-field probe calibration using the waveguide technique. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	ci	Standard Uncertainty (%)
Incident or forward power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Reflected power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field homogeneity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field probe positioning	5.00%	Rectangular	$\sqrt{3}$	1	2.887%
Field probe linearity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Combined standard uncertainty					4.509%
Expanded uncertainty 95 % confidence level $k = 2$					9.0%

5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Lab Temperature	21 °C
Lab Humidity	45 %

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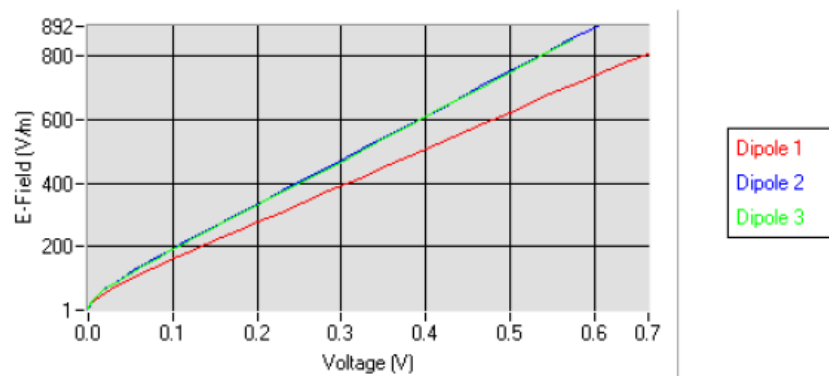


5.1 SENSITIVITY IN AIR

Normx dipole 1 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normy dipole 2 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normz dipole 3 ($\mu\text{V}/(\text{V}/\text{m})^2$)
4.84	4.37	4.63

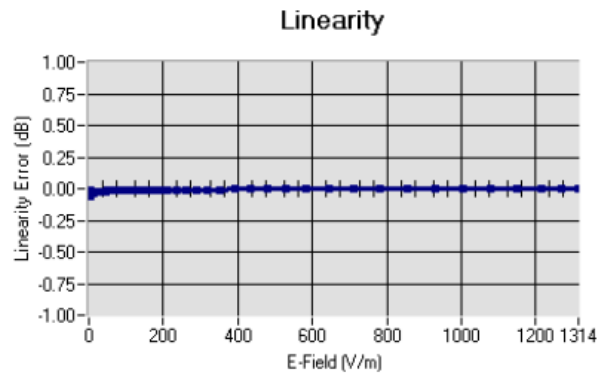
DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
120	119	122

Calibration curves



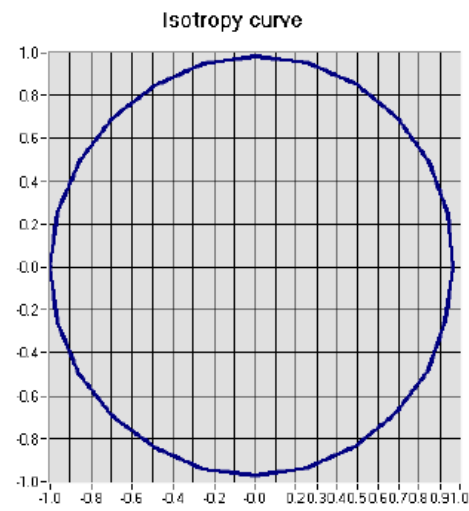


5.2 LINEARITY



Linearity: $\pm 1.49\%$ ($\pm 0.07\text{dB}$)

5.3 ISOTROPY



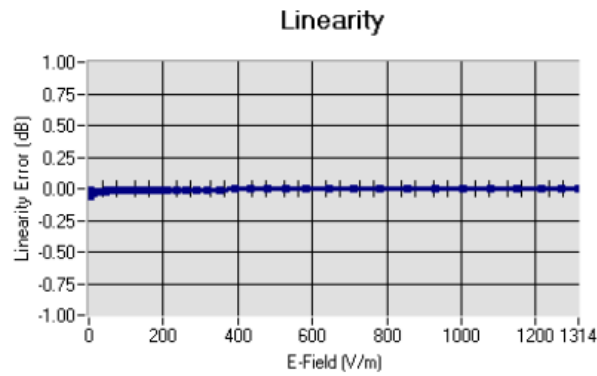
Isotropy: $\pm 2.02\%$ ($\pm 0.09\text{dB}$)

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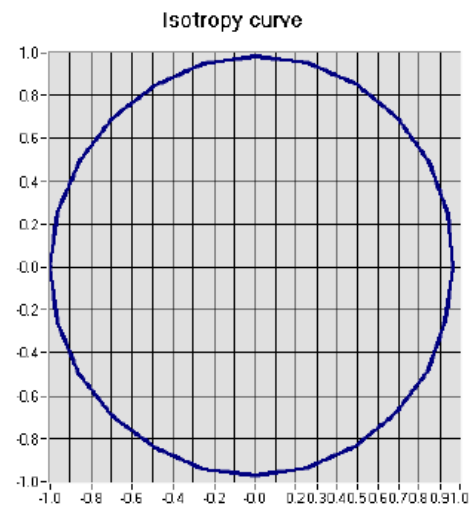


5.2 LINEARITY



Linearity: $\pm 1.49\%$ ($\pm 0.07\text{dB}$)

5.3 ISOTROPY



Isotropy: $\pm 2.02\%$ ($\pm 0.09\text{dB}$)

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6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
HAC positioning ruler	Satimo	TABH12 SN 42/09	Validated. No cal required.	Validated. No cal required.
COMOHAC Test Bench	Version 2	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2013	02/2016
Reference Probe	Satimo	EPH28 SN 08/11	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Reference Probe	Satimo	HPH38 SN31/10	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Multimeter	Keithley 2000	1188656	11/2010	11/2013
Signal Generator	Agilent E4438C	MY49070581	12/2010	12/2013
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	11/2010	11/2013
Power Sensor	HP ECP-E26A	US37181460	11/2010	11/2013
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	11-661-9	3/2012	3/2014

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H-Field Probe Calibration Certificate**COMOHAC H-Field Probe Calibration**

Ref: ACR.96.11.13.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT TESTING
(SHENZHEN) CO.,LTD
ELECTRONIC TESTING BUILDING,SHAHE ROAD, XILI
TOWN SHENZHEN,P.R.CHINA
SATIMO COMOHAC H-FIELD PROBE
SERIAL NO.: SN 02/12 HPH45**

**Calibrated at SATIMO US
2105 Barrett Park Dr. - Kennesaw, GA 30144**

**04/05/13***Summary:*

This document presents the method and results from an accredited COMOHAC H-Field Probe calibration performed in SATIMO USA using the CALIBAIR test bench, for use with a SATIMO COMOHAC system only. All calibration results are traceable to national metrology institutions.



COMOHAC H-FIELD PROBE CALIBRATION REPORT

Ref: ACR.96.11.13.SATU.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	4/5/2013	<i>JS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	4/5/2013	<i>JS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	4/5/2013	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	Shenzhen EMC-united Co., Ltd

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	4/5/2013	Initial release

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3.3	Isotropy	5
3.4	Probe Modulation Response	5
4	Measurement Uncertainty	5
5	Calibration Measurement Results	5
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6	List of Equipment	9

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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC H FIELD PROBE
Manufacturer	Satimo
Model	SCH
Serial Number	SN 02/12 HPH45
Product Condition (new / used)	New
Frequency Range of Probe	0.7GHz-2.5GHz
Resistance of Three Loops at Connector	Loop 1: R1=0.296 MΩ Loop 2: R2=0.459 MΩ Loop 3: R3=0.271 MΩ

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

Satimo's COMOHAC H field Probes are built in accordance to the ANSI C63.19 and IEEE 1309 standards.



Figure 1 – Satimo COMOHAC H field Probe

Probe Length	330 mm
Dimension of one loop	3.3 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	5 mm
Distance between loops / probe extremity	3 mm

3 MEASUREMENT METHOD

All methods used to perform the measurements and calibrations comply with the ANSI C63.19 and IEEE 1309 standards.

3.1 LINEARITY

The linearity was determined using a standard dipole with the probe positioned 10 mm above the dipole. The input power of the dipole was adjusted from -15 to 36 dBm using a 1dB step (to cover the range 0.01A/m to 2A/m).

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3.2 SENSITIVITY

The sensitivity factors of the three loops were determined using the waveguide method outlined in the fore mentioned standards.

3.3 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole. The probe was rotated along its main axis from 0 - 360 degrees in 15 degree steps.

3.4 PROBE MODULATION RESPONSE

The modulation factor was determined by illuminating the probe with a reference wave from a standard dipole 10 mm away, applying first a CW signal and then a modulated signal (both at same power level). The modulation factor is the ratio, in linear units, of the CW to modulated signal reading.

4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEEE 1528 and IEC/CEI 62209 standards were followed to generate the measurement uncertainty associated with an H-field probe calibration using the waveguide technique. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	ci	Standard Uncertainty (%)
Incident or forward power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Reflected power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field homogeneity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field probe positioning	5.00%	Rectangular	$\sqrt{3}$	1	2.887%
Field probe linearity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Combined standard uncertainty					4.509%
Expanded uncertainty 95 % confidence level $k = 2$					9.0%

5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Lab Temperature	21 °C
Lab Humidity	45 %

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COMOHAC H-FIELD PROBE CALIBRATION REPORT

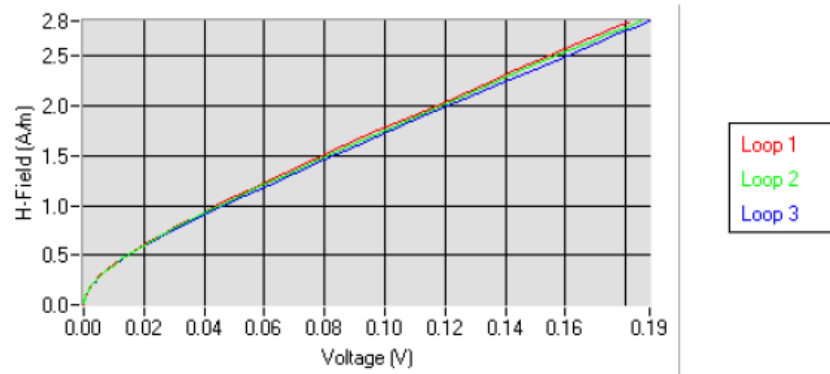
Ref. ACR.96.11.13.SATU.A

5.1 SENSITIVITY IN AIR

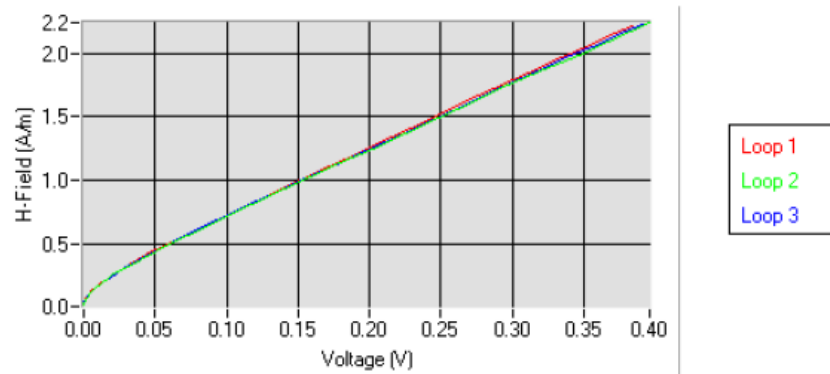
Frequency	Normx loop 1 (mV/(A/m) ²)	Normy loop 2 (mV/(A/m) ²)	Normz loop 3 (mV/(A/m) ²)
0.7-1.0 GHz	63.05	68.42	66.05
1.7-2.0 GHz	368.87	389.77	391.32

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
112	102	106

Calibration curves



Calibration curves



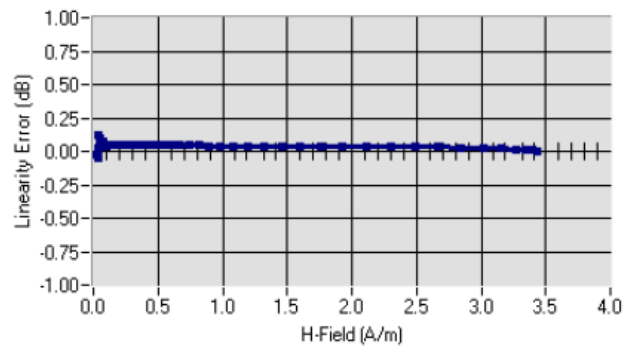
Page: 6/9

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5.2 LINEARITY

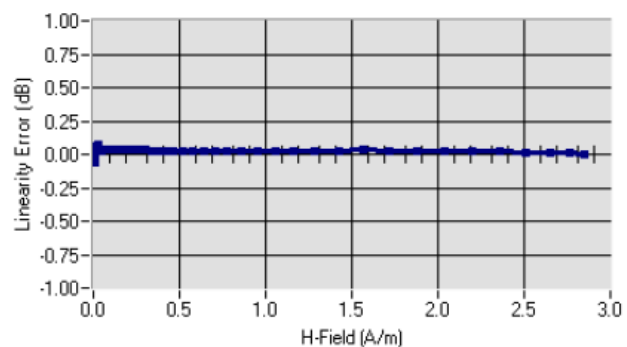
Linearity



Linearity: $\pm 2.92\%$ ($\pm 0.13\text{dB}$)

Linearity at 835 MHz

Linearity



Linearity: $\pm 1.64\%$ ($\pm 0.07\text{dB}$)

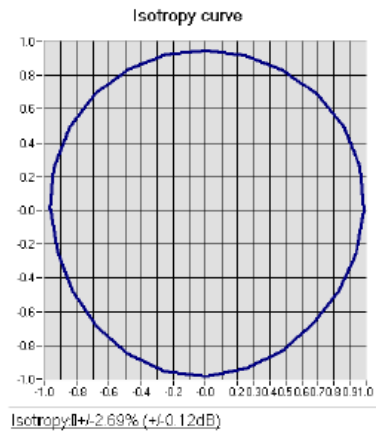
Linearity at 1900 MHz

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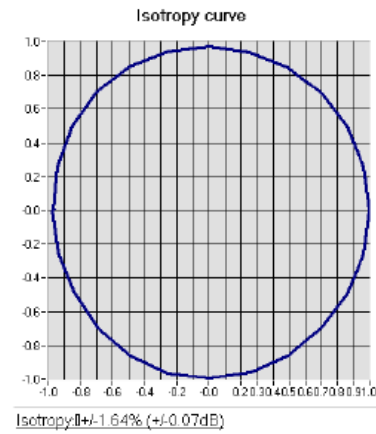
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5.3 ISOTROPY



Isotropy at 835 MHz



Isotropy at 1900 MHz

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6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
HAC positioning ruler	Satimo	TABH12 SN 42/09	Validated. No cal required.	Validated. No cal required.
COMOHAC Test Bench	Version 2	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2013	02/2016
Reference Probe	Satimo	EPH28 SN 08/11	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Reference Probe	Satimo	HPH38 SN31/10	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Multimeter	Keithley 2000	1188656	11/2010	11/2013
Signal Generator	Agilent E4438C	MY49070581	12/2010	12/2013
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	11/2010	11/2013
Power Sensor	HP ECP-E26A	US37181460	11/2010	11/2013
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	11-661-9	3/2012	3/2014

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T-Coil Probe Calibration Certificate



COMOHAC T-coil Probe Calibration Report

Ref : ACR.96.12.13.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT TESTING
(SHENZHEN) CO.,LTD**
**ELECTRONIC TESTING BUILDING,SHAHE ROAD, XILI
TOWN SHENZHEN,P.R.CHINA**
SATIMO COMOHAC T-COIL PROBE
SERIAL NO.: SN 24/11 TCP23

Calibrated at SATIMO US
2105 Barrett Park Dr. - Kennesaw, GA 30144



04/05/13

Summary:

This document presents the method and results from an accredited COMOHAC T-coil Probe calibration performed in SATIMO USA using the COMOHAC test bench, for use with a SATIMO COMOHAC system only. All calibration results are traceable to national metrology institutions.



COMOHACT-COIL PROBE CALIBRATION REPORT

Ref ACR.96.12.13.SATU.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	4/5/2013	
<i>Checked by :</i>	Jérôme LUC	Product Manager	4/5/2013	
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	4/5/2013	

	<i>Customer Name</i>
<i>Distribution :</i>	Shenzhen EMC-united Co., Ltd

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	4/5/2013	Initial release

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3.3	Signal to Noise Measurement of the Calibration System	5
4	Measurement Uncertainty	5
5	Calibration Measurement Results	5
5.1	Sensitivity	6
5.2	Linearity	6
5.3	Signal to Noise measurement of the Calibration System	6
6	List of Equipment	7

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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC T-COIL PROBE
Manufacturer	Satimo
Model	STCOIL
Serial Number	SN 24/11 TCP23
Product Condition (new / used)	New
Frequency Range of Probe	200-5000 Hz

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

Satimo's COMOHAC T-coil Probes are built in accordance to the ANSI C63.19 and IEEE 1027 standards.



Figure 1 – Satimo COMOHAC T-coil Probe

Coil Dimension	6.55 mm length * 2.29 mm diameter
DC resistance	860.6 Ω
Wire size	51AWG
Inductance at 1 kHz	132.1 mH at 1 kHz

3 MEASUREMENT METHOD

All methods used to perform the measurements and calibrations comply with the ANSI C63.19 and IEEE 1027 standards. All measurements were performed using a Helmholtz coil built according to the specifications outlined in ANSI C63.19 and IEEE 1027.

3.1 SENSITIVITY

The T-coil was positioned within the Helmholtz coil in axial orientation. Using an audio generator connected to the input of the Helmholtz coil, a known field (1 A/m) was generated within the coil and the T-coil probe reading recorded over the frequency range of 100 Hz to 1000 Hz.

3.2 LINEARITY

The T-coil probe was positioned within the Helmholtz coil in axial orientation. The audio generator connected to the input of the Helmholtz coil was adjusted to obtain a field within the coil from 0 dB A/m to -50 dB A/m and the T-coil reading recorded at each power level (10 dB steps).

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